CHAPTER - 3

a. CHOICE OF TECHNOLOGY IN COTTON TEXTILES: A CASE FOR BANGLADESH

b ESTABLISHMENT OF THE HYPOTHESIS AND EXTENSION OF THE METHODOLOGY TO DETERMINE ALTERNATIVE TECHNOLOGIES FOR BANGLADESH.FORMULATION OF THE TECHNICAL AND ECONOMIC PARAMETERS FOR THEIR EVALUATION.

CHOICE OF TECHNOLOGY IN COTTON TEXTILES - A CASE FOR BANGLADESH

The previous chapters have set the scene emphasising the important role of textile industry in the economy of Bangladesh in terms of value added and employment generation. This industry needs a formidable expansion to meet the domestic consumption of cloth. For sustained economic growth under the present population increase and growing labour-force this industry requires a creation of substantial employment opportunity. Agriculture appears to be the unlikely sector to generate employment and it indicates the need for the manufacturing and the service sectors activity to provide employment for the growing labour-force. Textile being the **second largest manufacturing** sector with the largest cottage based handloom industry appears to have the potentials for future expansion and employment generation. It has also been established that technology choice is not rigid rather it is an emperical phenomenon with a variety of alternatives present to choose from. Exixting literature **on** technology choice have also emphasised this fact. It would therefore be pertinent to examine closely the existence of any technological choice, and if there is , then to ascertain the relationship between economically effecient choice and its implications on employment and its role in alleviating the present problem of growing labour-force.

The present textile policy of the Bangladesh Govenment is to conduct textile production under the public sector, and specifically to produce intermediate product such as yarn to supply the traditional handloom and some organised private sectors who are producing specialised type of fabric. 1/ The intention behind this policy was to protect and as well as to expand employment in the rural areas. The Government has established special Board and Institution for handloom weavers to faciliate the expansion of this sector in terms of capacity, production and employment (See Chapter 3). It has been the policy of the Government since 1973 not to encourage the installation of any mechanised looms in the organised sector*/in order to offset any competitive advantage of the handloom weavers. Therefore, since that period the organised sector experienced only

*/and to maintain some form of product reservation f handloom,

1/ In 1981-82, some of the textile mills which were under Bengali ownership at the time of nationlisation were disinvested by the Govt. in the pusuance of the new industrial policy. This policy also broke the monopoly of the Public increase in spindle capacity(See chapter 2). Although, some loom capacity in the organised private sector had been increased but it only concentrated on the production of specialised fabric with synthetic fibre like nylon shirting, terylene suiting, bed-sheets, etc. This brings out an important issue as to whether the present textile policy pursued by the Government has any economic rationale. As has already been established by numerous literature the relative economic ineffeciency of traditional technologies,then what is the economic cost of pursuing such a policy ? Also , as already mentioned that others had argued in favour of the adoption of a third technology i.e either second-hand machinery procured from developed countries 2/ or the use of re-built technology (conventional)to operate under small-scale production or even the adoption of cottage spinning with one pedal loom of the type in use by the Khadi and Village Industries Commission (KVIC) and also the technology recommended by the Appropriate Technology Development Association (ATDA). But all these technologies are not at present in operation in Bangladesh, but widely in use in India. It would be an important economic proposition as to whether these technologies would provide any alternative to the textile manufacture in Bangladesh. Another essential aspect of textile production , is the productivity level of different technologies. It has been suggested in many literature that the economic suitability of alternative production method would depend on the operating conditions i.e productivity factor endowment, prices and other socio-economic characteristics of the country. It would therefore be relevant to ascertain the technology option within the technical, economic and social parameters of Bangladesh.

Finally, it is necessary to isolate the area of study because the textile industry consists of all textile fibres viz. jute, cotton and synthetic fibres. It has been discussed in details in Chapter-3,'The Textile Industry In Bangladesh', that cotton is the single fibre used in weaving fabric which bears great importance.

Sector ownership,and encouraged Private Sector investment in Spinning. However, the non expansion policy of mechanised loom in cotton textiles still remains,and such expansion is possible only for specialised fabrics.

2/ In recent years,the private entrepreneurs have imported second hand machinery from Japan,South Korea,Germany,Belgium and UK to set up small weaving mills to produce specialised type of fabric viz. terylene shirting, polyester suitings,etc.

In fact, almost 98 per cent of all fabric production is of cotton, while about 2 per cent is of synthetic (table 1.2.9). Among the cotton fabric, the medium quality dominates the share of production occupying about 90 per cent of the cloth production. Therefore, it would be reasonable to pursue technology choice in the textile industry in Bangladesh based on cotton textiles and medium quality cloth.

Introduction

This chapter forms a part of the process which examines the choice of technology in the cotton industry in Bangladesh. To aid the choice of technology , it establishes several hypothesis based on the objectives set at the introductory section of Chapter-1. These hypothesis which can be put to test, encompasses the issues of available alternatives technologies, whether any choice is worthy of consideration for Bangladesh among these alternatives and also the examination of the present textile policy. In this section , first of all a methodolgy has been developed in line with that evolved in Chapter-3 in order to identify the number of alternative technologies available at each sector level i.e by combination of modern, intermediate and traditional technologies. It further , decomposes the entire textile process into four sub-processes (Pickett, 1977) and determines the alternatives available by combining these sub-processes among the three sectors. It however assisted the selection of some technically feasible technologies suitable under Bangladesh conditions , which are to be evaluated and treated in a detailed discussion. The sources of information which have aided in determining these technology options such as India, , Bangladesh and others have been discussed alongwith the type of information collected. Finally, it has established and discussed the technical and economic parameters which enable technology choice between modern, intermediate and traditional technologies.

Establishment of Testable Hypothesis

The testable hypothesis could be postulated as follows :-

a. Alternative technologies are available in the modern(organised) textile manufacturing sector.

b. The introduction of 'intermediate technology' and hand-spinning of the type developed in India(decentralised sector) in conjunction with pedal,power and handloom(dispersed sector) are economically viable and will create additional employment.

c. In Bangladesh, the combination of modern spinning and traditional weaving, as has been the present textile policy of non-expansion of the power loom for cotton products in order to protect rural employment, is a better alternative than the modern spinning unit with automatic power loom.

The process which follows from here are developed in order to enable to test these hypothesis. As has been seen in Chapter - 3, that there are numerous alternatives present to choose from. Therefore, the task of this study would be to establish some of these results at Bangladesh condition and make evaluation of the complete process technologies by using the country's factor availability, prices and productivity level.

Establishment of Alternative Technologies under Bangladesh Condition

Sub-process Characteristics

The textile process at the factory building begins with cotton , which comes in the form of a bale. The operation which preceeds the factory operation is known as ,'ginning'. The 'ginning' is a mechanical operation, whcih separates the cotton from its seed and takes place in a farm house. In the factory,the raw- material passes through a number of operations and the entire process an be categorised into four major groups given as follows.3/

TABLE

	Categories	Sub-Processes	Product
1.	Pre-spinning (Stage I)	Opening and Cleaning Carding, Drawing and Roving	Roving
2.	Spinning &Ring-Finishing(RF) (Stage II + RF)	Spinning, Cone-Winding, Reeling, Bundle pressing, Bailing.	Yarn in bale form.
3.	Preparatory Weaving (Stage III)	Cone Winding, Pirn Winding,Warping, Sizing and Drawing-in.	Yarn Beam and Weft Pirn.
4.	Weaving & Finishing (Stage IV)	Weaving, Cloth checking and folding and Bailing.	Fabric in Bale form.

Among these categories the most important operations are spinning and weaving. The combination of the sub-processes would depend on the type of finished product required. If the output desired is roving then category one will furnish such product. But if the yarn is required as final product as an input

3 'Technology and Employment in the Production of Cotton Cloth,'

for a separate weaving mill or for the handloom sector, then all the sub-processes under the categories are required. However, if 'cloth' is the required final product under the same factory shed , then all the sub-processes would be required in the four categories with the exception the finishing operations at the spinning-stage viz. Cone Winding, Reeling, Bundle Pressing and Baling. Under such circumstances, the yarn would be directly transferred to the Preparatory weaving shed.

These stages of production are strictly maintained if the yarn or fabric is being produced under a factory shed condition. But if they are produced in a small-scale factory or by hand-spinning and weaving, some of the processes are excluded for example Cone-Winding which forms a part of the spinning. The complete textile process for the organised, decentralised and traditional sectors have been shown in figure 4.1

Extension of the Methodology

It is important to identify the alternative sectors of textile production before determining the alternative technologies. Boon has described four options which in his opinion are available for a developing country. 4/ They are listed as follows :-

i) No textile industry
ii) Cottage textile industry
iii) Modern textile industry
iv) Both modern and cottage textile industry

As mentioned earlier, that technology type is closely related with sectoral organisation of production which has been clearly illustrated with the help of figure 4.2(Page 8) . The figure shows that there are a number of options present for a developing country as to whether they would like to produce textiles either in the

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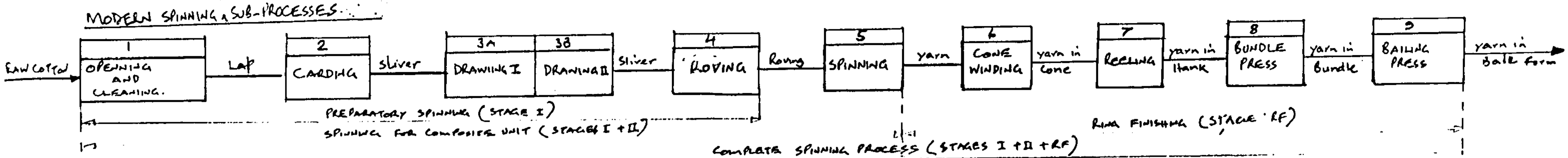
by Pickett,J and R.Robson, World Development, Vol. 5, No. 3, pp.204. Picett and Robson identify 4 stage in the complete textile process. However, they have included pirn winding in stage 4 of the weaving.

4/ 'Dualism and Technological Harmony for Balanced Development' of the Textile Industry', by Boon, G.K., Appropriate Industrial Technology for Textiles, Monograph-6, New York,December,1979, pp. 70-71

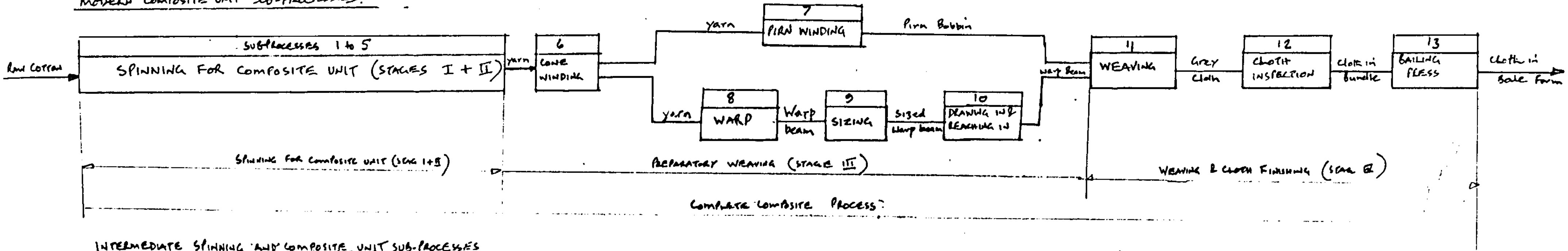
FIGURE 4.1

SUB-PROCESSES OF MODERN, INTERMEDIATE AND TRADITIONAL TECHNOLOGIES

MODERN SPINNING UNIT SUB-PROCESSES



MODERN COMPOSITE UNIT SUB-PROCESSES.

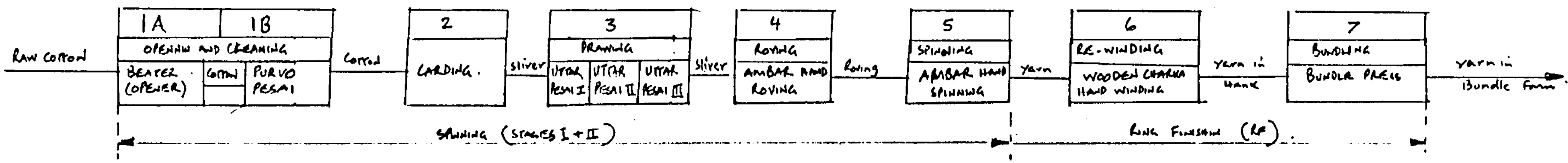


INTERMEDIATE SPINNING AND COMPOSITE UNIT SUB-PROCESSES

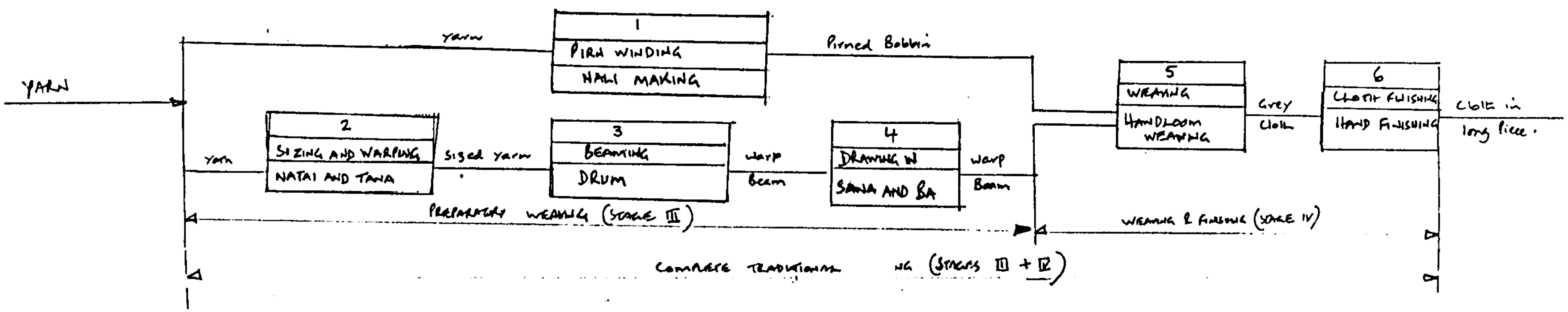
SPINNING UNIT: The [illegible] are identical to modern spinning, except that there are 3 passages in Drawing operation (Drawing I (3A), Drawing II (3B), and Drawing III (3C)), and there is no Bailing press [illegible] last process.

COMPOSITE UNIT: The sub-processes are same as the modern composite unit, except that there is no bailing press i.e. all sub-processes 1-12 inclusive.

KVIC SPINNING UNIT SUBPROCESSES



TRADITIONAL HANDLOOM WEAVING



organised or decentralised or the dispersed sector. As already discussed (Chapter - 2) in Bangladesh, textile products are manufactured in all the sectors, however the use of Ambar or pedal charka and pedal weaving are virtually non-existant.

The determination of the alternative technologies would be based on the four independent stages of production identified earlier which is somewhat similar to the method Pickett and Robson (1977) had developed when comparing technology choice of two wage areas. 5/ Pickett's method has identified the entire process into four stages of production and thereafter replaced each stage of production in an orderly progression by conventional, intermediate and automatic technologies. A number of technically feasible alternative technologies is generated as a result of this. A later study(1981) by the same authors recognised even a wider range of alternatives by identifying the textile process into eleven independent sub-processes. With each sub-process having further alternatives, the authors had identified over 2000 technically feasible alternatives. The method used is the one developed by the David Livingstone Institute (DLI) known as the DLI method. As already mentiond , the methodology which would be applied here is the one previously used by Pickett and Robson (1977),even though the method developed later(1981)is justifiably superior. The present study considers four sources of production for the modern method of production viz. UK, Japan, Rumania and India,while the DLI studies have considered a single source of machinery.This obviously, creates the problem of dealing with a considerably higher number of alternatives. Furthermore, these alternatives also exist within the intermediate and cottage technologies and these together would create a very large number of alternatives , which may burden the objective of this study. Rather emphasis here, will be given on practised technologies and prices of alternative sources of machinery within the modern sector and their productivity under Bangla-

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5/ As mentioned in the foot note(1/), Pickett and Robson have included Pirn Winding with the Weaving,however,in this study Weaving will be considered as a completely seperate process, while Pirn Winding will be included in Preparatory weaving.

FIGURE 4-2

ALTERNATIVE SECTORS OF CLOTH PRODUCTION

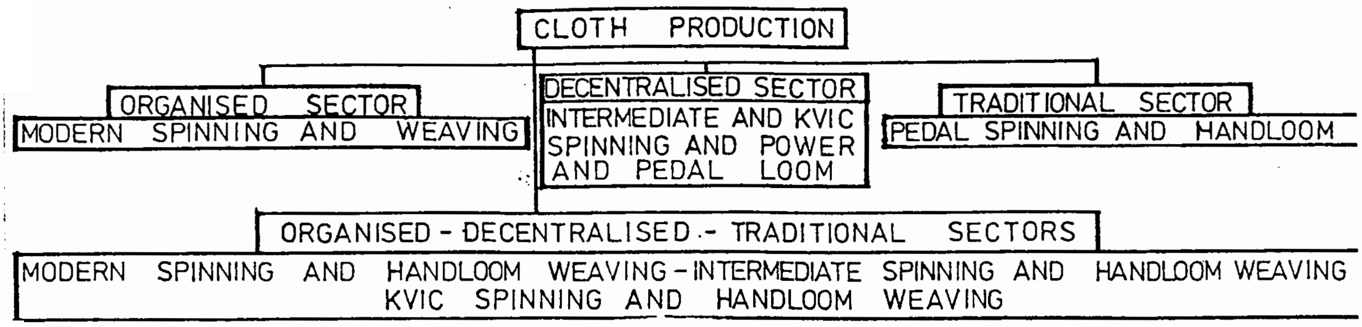
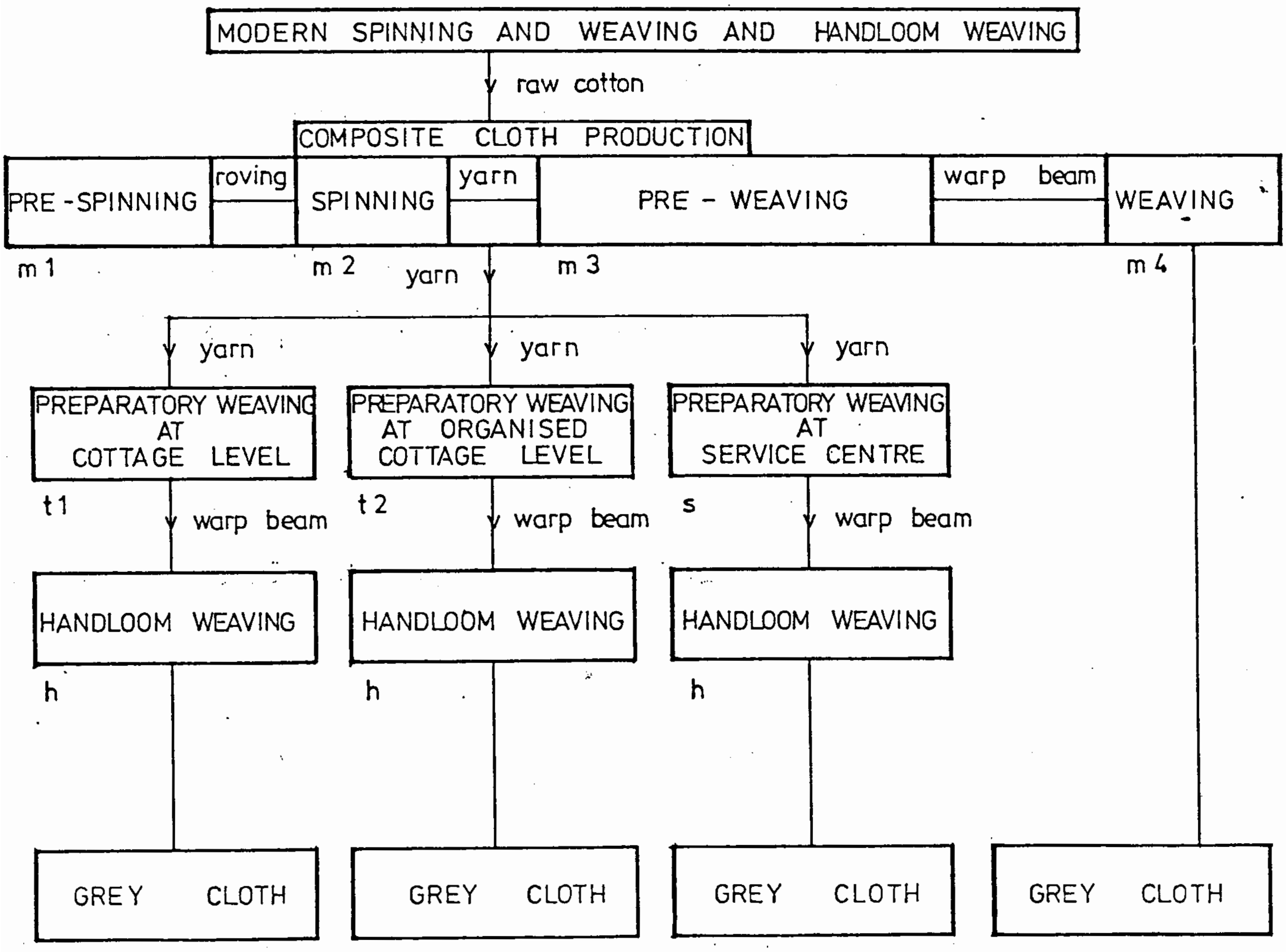


FIGURE 4-3

ALTERNATIVE TECHNOLOGIES OF CLOTH PRODUCTION

ORGANISED AND TRADITIONAL SECTOR

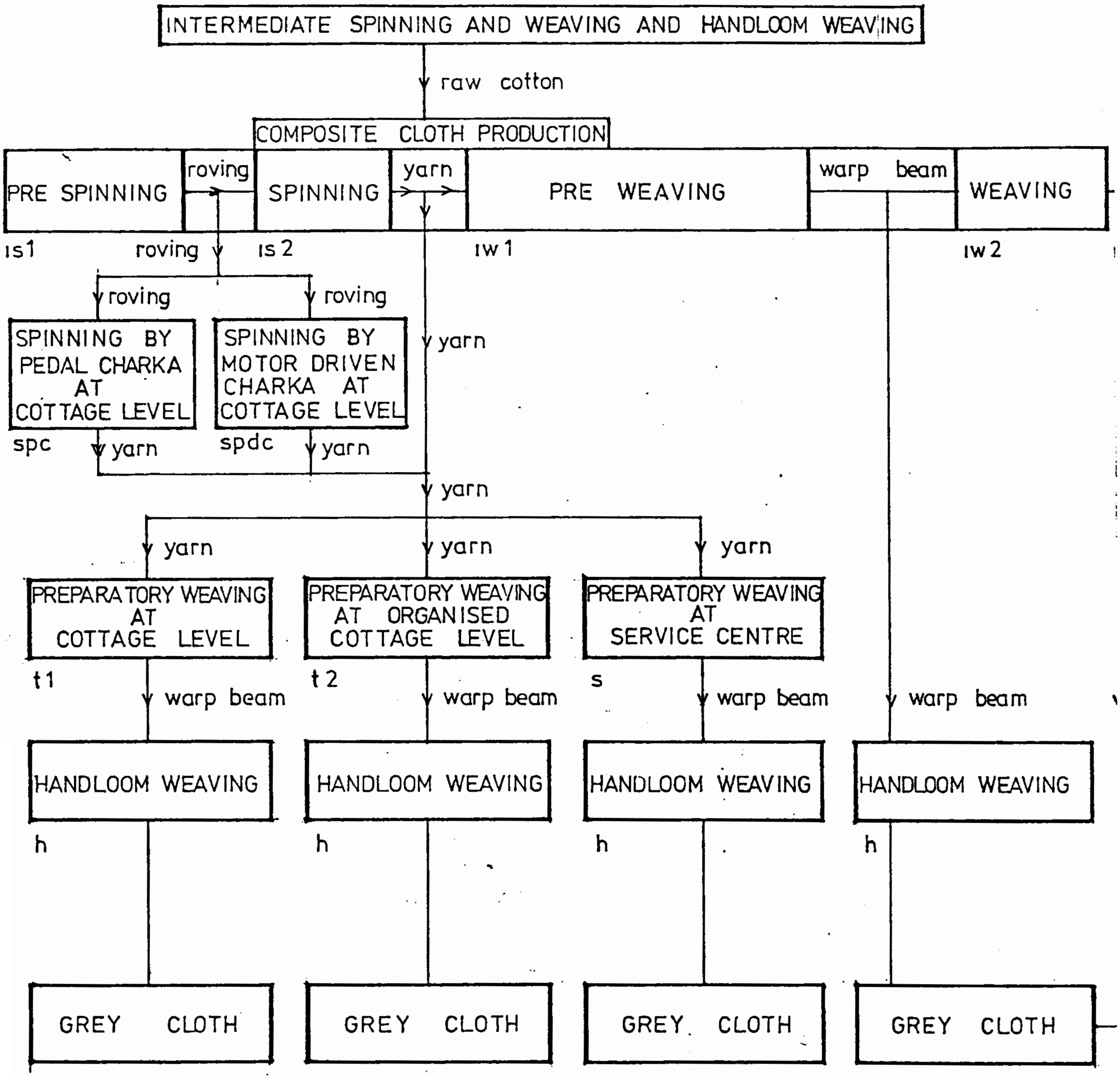
(MODERN AND HANDLOOM TECHNOLOGIES)



m 1	=	MODERN PRE - SPINNING TECHNOLOGY
m 2	=	MODERN SPINNING TECHNOLOGY
m 3	=	MODERN PRE - WEAVING TECHNOLOGY
m 4	=	MODERN WEAVING TECHNOLOGY
t 1	=	PRE - WEAVING TECHNOLOGY AT COLLEGE LEVEL
t 2	=	PRE - WEAVING TECHNOLOGY AT ORGANISED COLLEGE LEVEL
s	=	PRE - WEAVING AT SERVICE CENTRE USING INTERMEDIATE TECHNOLOGY.
h	=	HANDLOOM TECHNOLOGY COULD USE EITHER PIT OR SEMI-AUTOMATIC LOOM.

FIGURE 4-4

DECENTRALISED AND TRADITIONAL SECTORS (INTERMEDIATE AND HANDLOOM TECHNOLOGY)

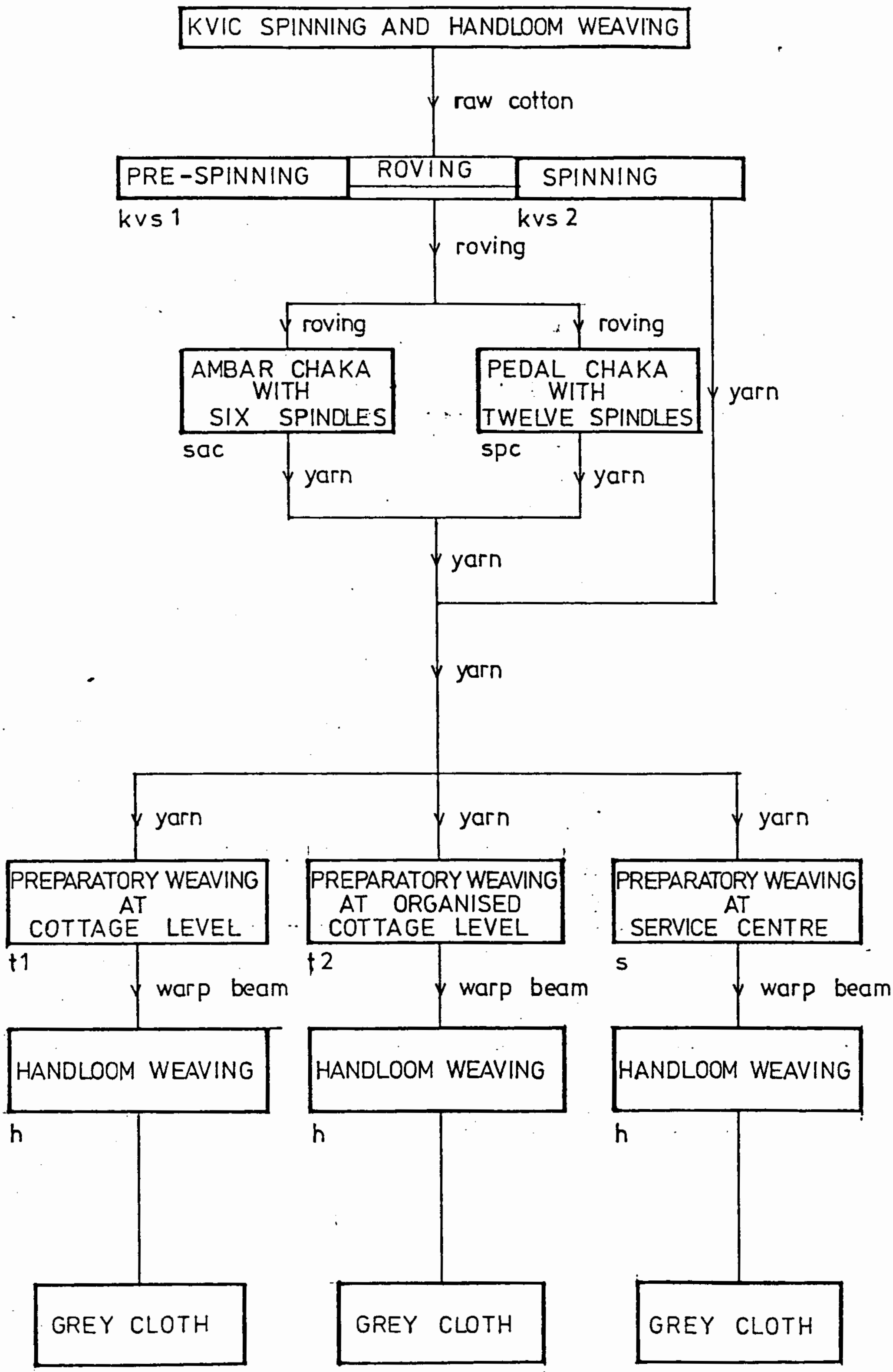


is1 = INTERMEDIATE PRE-SPINNING TECHNOLOGY
is2 = INTERMEDIATE SPINNING TECHNOLOGY
iw1 = INTERMEDIATE PRE-WEAVING TECHNOLOGY
iw2 = INTERMEDIATE WEAVING TECHNOLOGY, COULD USE EITHER PEDAL OR POWER LOOM.
spc = SPINNING BY PEDAL CHARKA AT COTTAGE LEVEL
spdc = SPINNING BY POWER DRIVEN CHARKA AT COTTAGE LEVEL

FIGURE : 4-5

c DECENTRALISED AND TRADITIONAL SECTOR

(KHADI AND VILLAGE INDUSTRIES COMMISSION (kvic) AND HANDLOOM TECHNOLOGIES



kvs 1 = kvic PRE - SPINNING TECHNOLOGY
kvs 2 = kvic SPINNING BY AMBAR CHARKA AT FACTORY SHED
sac = SPINNING BY AMBAR CHARKA AT COTTAGE LEVEL

desh condition . However ,the choice which exists at the sub-process level would in no way be undermined, and moreover, it would be recognised that such choice **may** compliment the modern sector more than the decentralised and dispersed sectors. Finally, the choice of technology at four stages of production , would not be a replacement of stages in an orderly progression by conventional , intermediate or advanced technologies, rather it would be combined with the intermediate, KVIC and handloom technologies. **From** the alternatives ,technically feasible and already practised technologie would be selected for evaluation under Bangladesh condition.

Alternative Technologies

Alternative technologies of cloth production which combine the four stages of production for modern, intermediate and cottage technologies have been shown in figures 4.3,4.4 & 4.5. From these figures a large number of complete processes can be combined. There are as many as 47 technically feasible technologies*/which can be identified and are presently in practice in some form in India. However,for the present study, **twelve** most commonly practised technologies in India shall be considered for evaluation under Bangladesh condition.These technologies have been discussed below.

*/as shown in appendix

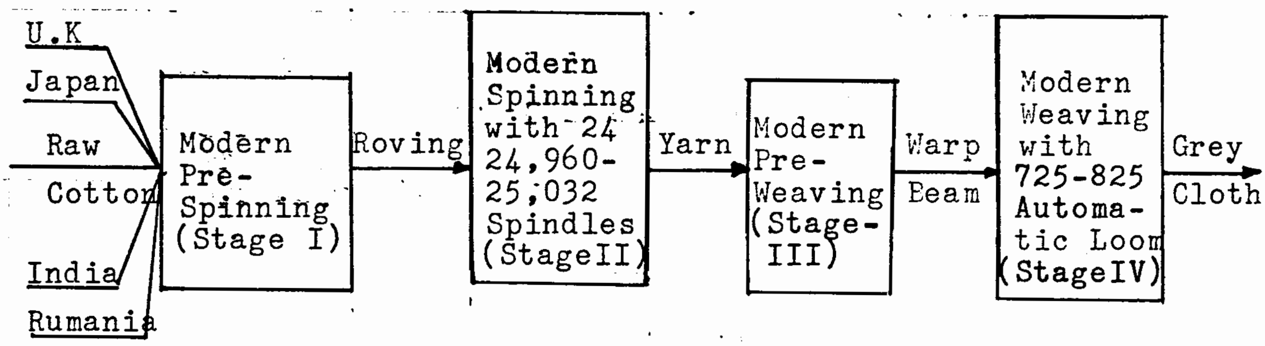
Technology 1-4 Modern Spinning and Composite Unit

Both spinning and composite technologies are in operation in Bangladesh. Spinning technology combines the first two stages of production i.e pre-spinning with spinning and Ring-spinning to produce yarn as an*/product. While the composite unit combines all the four stages of production i.e in addition to the two stages for spinning , it combines preparatory weaving and weaving. These complete process technology could be combined by alternative sources of machinery viz. UK, Japan, Rumania and India. All these sources would distinguish for itself a complete independent technology. These technologies can be arranged as follows :-

*/intermediate

Technology 1 to 4

Modern Composite Unit



These technologies are all at present operating in Bangladesh. There are 65 textile mills in Bangladesh, out of which 25 are composite in nature and they were established before Bangladesh came into being. It was a deliberate textile policy since 1973, not to install any composite mill in order to protect the rural handloom employment.

Technology 5&6 Modern Spinning and Handloom Weaving

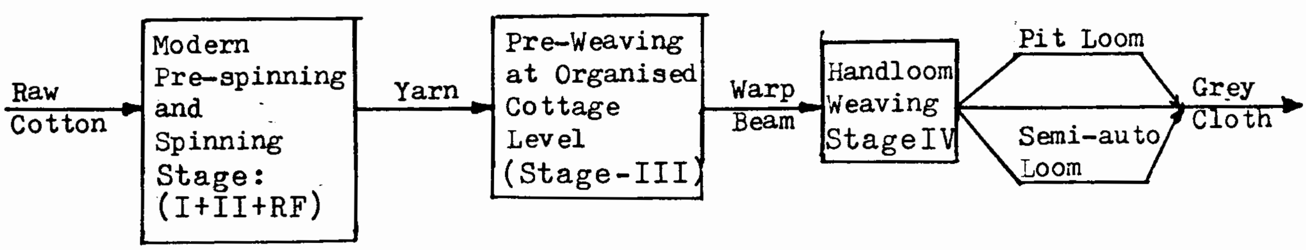
Modern spinning can be combined with the traditional sector i.e handloom weaving. Acharya et.al (1978) and Sabhaney (1978) and others have suggested such combination to help sustain the present employment level of the rual sector. Since 1972, the textile policy of the Bangladesh Government have been geared to promote such technology combination. For the purpose of evaluation of alternative technologies, it becomes apparent that such combination can be achieved with alternative sources of spinning machinery. It has been observed that the developing countries are producing identical machinery with less automation at a relatively cheaper price. Because of their less labour-saving feature they are able to create more employment. The use of such technologies have been advocated by the Industrial Forum on Appropriate Industrial Technology for Textiles in Delhi (1978). Ideally, the best combination of technology would be the most effecient technology in the spinning unit combined with handloom weaving

Further rise in the number of alternatives takes place if the handloom types found in Bangladesh are taken into consideration. There are four main types of looms in Bangladesh and among them the most widely used are Pit and Semi-automatic looms,*/also known as Chittaranjan looms (C.R looms) (See Chapter-2). There is also choice among preparatory weaving process within the cottage level viz. at cottage level in **individual units** or in organised form (See diagram 4.3). The individual conducts its preparatory process at home and mainly with the assistance of family labour, whereas, in the organised form it is sub-contracted to others for warping and sizing. The latter method was found to be quite popularly used, and has therefor , been considered as an alternative. The alternative technologies can be combined as follows :

*/the latter is

Technology 5 and 6

Modern Spinning and Handloom Weaving



It is therefore to be noted that if alternative sources of machinery are being used for modern spinning then the number of alternatives would be increased. As discussed earlier, that appropriate technologies would be the combination of the most effecient modern spinning with alternative types of handloom. However, it would be interesting to see the combination of each loom type with alternative sources of spinning machinery.

Technology 7 : Modern Spinning, Service Centre and Handloom

Technology combination with the 'Service Centre' would replace the preparatory weaving at cottage level by small-scale factory operation. In the service centre, Cone-Winding, Warping, Sizing operations are combined together to supply warp beam to the handloom weavers. This alternative was first introduced by the Appropriate Technology Development Association, India, which claims that it could save atleast 10 to 12 per cent preparatory cost for the handloom weavers.It supplies yarn beam to the pedal loom weavers who use ATDA developed looms. Similar methods of supplying yarn beam to the pedal loom weavers are in practice in South India, where it is being organised by the KVIC and is known as,' Lok Vastra Scheme'. 6/ In Bangladesh,a kind of 'service Centre' facilities are extended to the handloom weavers,under the administration of Bangladesd Handloom Board (See Chapter-2). However, they mainly provide help for fabric finishing. This combination has some operational constraints if introduced in Bangladesh because of the kind of looms which exists The pit and C.R looms ,which occupy about 85 per cent of the total loom capacity are equipped with beams which carry much shorter length of warp than the pedal loom. Therefore, the service centre would have to introduce an additional operation which would transfer large-beam into smaller warp beam to be used for the handloom. However , it is possible to make small length beam in the sizing stage, but it would reduce sizing effeciency drastically. . The alternative technologies can be combined as follows :-

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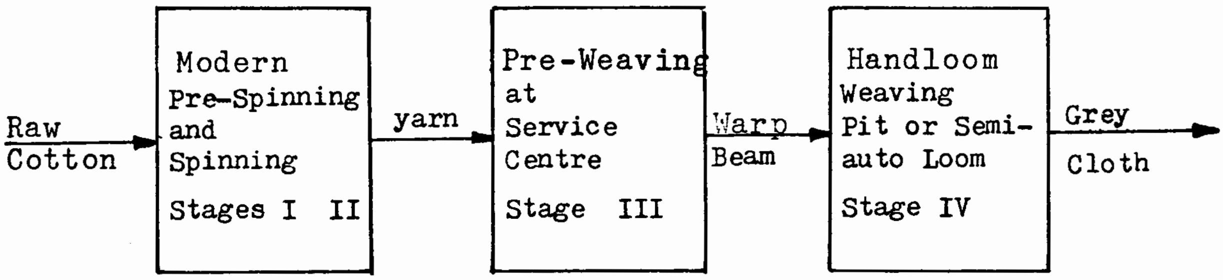
6/ It raises the question,whether a prepared beam could be carried from the Service Centre to the weaver's home. In ATDA(Kusmi-Kalan),it has been observed that such beam of 700 yds(approx. weight 70lbs.)were carried by weavers.

Technology 7

Modern Spinning, Service Centre and Handloom Weaving



The technology above combines the most effecient modern spinning, Service Centre and handloom technology using either Pit or C.R looms depending on the type which had emerged as the most effecient. The textile production process which combines the Service Centre is not presently in practice in Bangladesh. The Service Centre which has been developed by the ATDA has both preparatory spinning and preparatory weaving under different factory-sheds, and as independant units in the same premises. The Service Centre' refers to both these units. However, in the present study, 'Service Centre technology' would be used only to refer to preparatory weaving, preparatory spinning at the Service Centre level would be referred to the ATDA (Roving) Centre. The Service Centre functions as a small production unit to provide services to the weavers. The technology for modern production weaving would not realise the technical economies of scale especially for warping and sizing machinery. Therefore, the machinery for the Service Centre would be selected from the intermediate technology developed in India.

Technology 8 to 10: Intermediate Spinning and Weaving Technology

The decentralised sector as it is defined in India do not exist in Bangladesh. In South India, decentralised spinning units with upto 1,000 spindles are in operation. It is also technically possible to increase the number of spindles upto 5 to 6 thousand. The technology used by this sector consists of re-built machinery, at least for sub-processes like Opening and Cleaning, Carding and Roving,while drawing and spinning machinery are built by the local manufacturers. Weaving preparatory machines viz. Warping , Sizing and the looms are built by the local manufacturers as well. All these machinery have been designed to suit small-scale production units for spinning and weaving. The decentralised textile production in India can be categorised into two main systems.

The ATDA Service Centre Technology

The objective of the Appropriate Technology Development Association (ATDA) is to develop a technology which will help to increase the earnings of the cottage spinners and weavers. It argues that by developing a technology which will supply roving and processed warp beam to the cottage spinners and weavers the yarn cost will be reduced upto 16-22% and, while the preparatory cost upto 10-15% (See Chapter-3). It recommends a 'Service Centre' approach which would supply roving' and processed 'beam'. The ATDA has an experimental unit working for the last five years in Uttar Pradesh, India. This centre uses re-built spinning preparatory machinery to produce roving and a separate weaving preparatory unit, which produce warp beam. The ATDA has developed spinning frame and pedal loom which are distributed among the cottage spinners and weavers at a low deposit and for small monthly payments towards the cost. These spinning frames could be with 12 spindles and either power operated or manually driven by pedal. These units could be connnected from a single spinning frame of 24, 36 and 48 spindles. It operates as two forms of spinning units; a type of unit where it uses pedal spinning unit operated manually by the cottage weavers with no access to electricity, and the other , where it combines a few 12-spindles units and operates by electric power. 7/ Both the units receive their roving from the 'Service Centre', and should ideally sell their yarn to the Centre. The unit which processes warp-beam uses yarn which are bought from the Pedal spinners. The processed beam are distributed among the cottage weavers who use ATDA developed pedal looms.

7/ When a few frame are combined and operated by electric power, then there would be insignificant difference between ATDA and the RFC spinning frames.

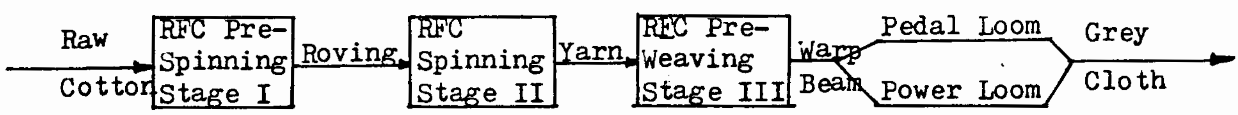
Rural Fabrice Centre (RFC) Technology

The decentralised unit of the type promoted by the Khadi and Village Industries Commission(KVIC), India , under the 'Lok Vastra Scheme' comprises of both spinning and weaving with pedal looms and is known as the Rural Fabric Centre. Such a unit receives generous financial help from the KVIC and uses re-built and locally manufactured machinery as already mentioned. In fact, there is very little difference between RFC and the ATDA technology as both use re-built preparatory machinery. One such RFC unit in South India has a capacity of 1,000 spindles and 10 pedal looms. Units of this kind have also been established in West Bengal. The RFC unit unlike the ATDA Service Centre, spins yarn and processes beam for supplying to the pedal loom weavers, in the same premises. The other important difference is that it does not process raw-cotton in the same premises. The Opening and Cleaning operations take place centrally and then processed laps are supplied to four Rural Fabric Centres.

From the decentralised units of ATDA and RFC types a number of combined technologies are possible. The alternatives considered here for the purpose of evaluation are technologies which are presently in practice in India. These alternatives could be as follows :-

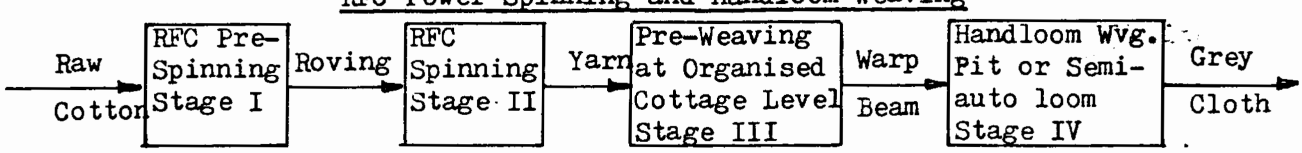
Technology 8 and 9

RFC Composite Unit With Pedal and Power Loom



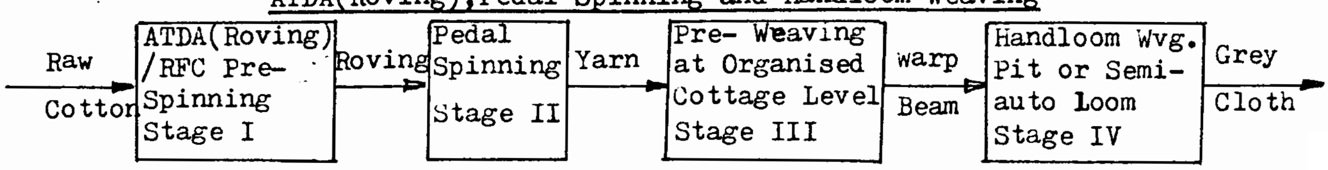
Technology 10

RFC Power Spinning and Handloom Weaving



Technology 11

ATDA(Roving),Pedal Spinning and Handloom Weaving



Among the alternative combinations chosen above, power-spinning at cottage level has been excluded as suggested by the ATDA. This was so because , as the cottage weavers in Bangladesh would find it difficult to have access to power supply. Instead a replacement of bamboo spinning 'Charka' by pedal charka which is presently used by the cottage spinners would be a more practical consideration. Moreover, the RFC technology includes power spinning, which has similar production capacity as the ATDA power spinning. In this study, Rural Fabric Centre technology has been modified by the inclusion of power loom. Even though, Power loom weaving is an important sector in India, but they exist as separate units and are not combined with RFC Power spinning.As one of the alternative Technologies in the present study,it has been considered as a composite production unit combining intermediate power spinning with power loom weaving.

All these combinations of technology are not in operation in Bangladesh. Therefore, the introduction of these technologies has to be organised either in public sector level or through initiative from private entrepreneurship. A recent report advocated such initiative to come from external donor agencies (ITIS & ATDA). 8/The donor agencies suggest the transfer of ATDA Service Centre and pedal-spinning technology to areas of Bangladesh where hand-spinning is predominant. It maintains that, the transfer of this technology would increase the present daily income of the handloom weavers from Tk.5/10 to Tk. 20. Therefore, the alternative chosen for intermediate technology has important implications in the production of textiles.

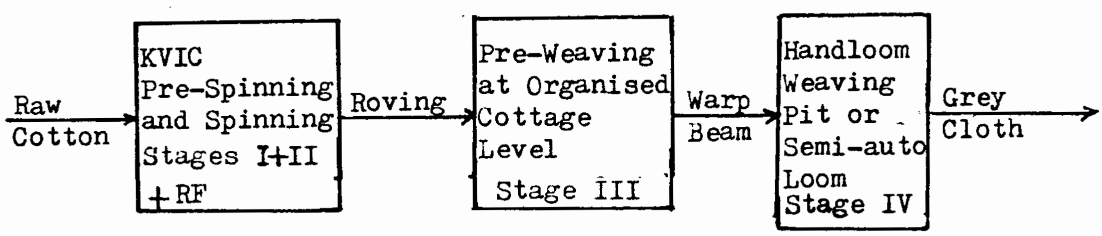
Technology - 11 : Khadi Spinning and Handloom Weaving

Khadi spinning is well known in India because of its being the symbol of self-reliance as preached by Ghandhi during the 1930s and the '40s. It meets about 1 per cent of India's total yarn consumption. The spinning technology used in Khadi yarn making has underwent through a series of development. The single spindle wooden charka has been replaced by a four spindle one in the early 1950s, known as the Ambar Charka. Sri Balasundaram, a mechanical engineer who engaged himself in developing the Indian textile machinery since 1950 made further improvements on the four

8/ A Pre feasibility Project Profile on Small-Scale Cotton Spinning, by Mia Alam, M.S., Micro Industries Development Assistance Society (MIDAS), Dhaka, November, 1983. The study spindle charka . He introduced the six spindles model charka incorporating into it many features of the standard mill machinery, known as the New Model Charka. The KVIC has initiated development of preparatory spinning machinery with production capacities suited for small-scale production. These machinery are known as , 'Purbo Pesai' (for Opening and Cleaning of cotton), Carding and Drawing (Uttar Pesai) and are driven by power,while Roving is made by a hand-operated charka identical to the New Model spinning charka, but has four spindles.Khadi production is mainly organised in two ways:one is organised through a Khadi Institution which provides input supply, marketing and development of the product, maintenance and training. In this system, the Roving and Spinning Charka are distributed to the cottage level, and the organisation supplies Sliver and Roving to the cottage rover and spinner. They in turn hand their finished product to the Institution in exchange for payment on the quantity of material processed(in lbs.) The other method of production organised is under factory shed known as, 'New Model Charka Unit'. This method uses all preparatory machinery and supplies Sliver to Roving charkas and subsequently roving to New Model Charka under the same premises. All operatives function on daily basis and get paid on the amount of output produced(in lbs). Unlike the Rural Fabric Centre, Khadi weaving is not organised under factory production system. Handloom weavers are organised under the Khadi Institution from where they receive their yarn. They return grey woven cloth to the same institution and get paid on the length of the woven fabric. They do not use pedal loom instead use pit or semi-automatic looms which they already own. The KVIC technology alternatives are as follows :-

Technology 11

KVIC Spinning and Handloom Weaving



purposes the setting up of a 'Service Centre' in the handloom concentrated area(Comilla),Bangladesh with technical and financial co-operation of ATDA,India and Intermediate Technology Industrial Service(ITIS),Rugby,UK.

The KVIC spinning technology is not widely used in Bangladesh, except in one Institution where hand-spinning is organised under factory condition.8A/ In this Institution, KVIC developed preparatory spinning and a few of the New Model Charka are used on an experimental basis. But in general, hand-spinning technology is dominated by primitive Opening and Cleaning operations known as 'Dhunai' and followed by bamboo or wooden charka spinning. A replacement of the present hand-spinning with KVIC technology could be one of the ways of improving income and the quality of product of this sector. The KVIC spinning, offers itself as an alternative spinning technology.

SUMMARY

The alternative technologies discussed above have been summarised in table 4.2 . It shows that there could be twelve(12) complete textile technologies capable to produce intermediate product of 32s Enlish count yarn and grey fabric with construction of 52 picks and 52 ends and 0.25 selvedge on both sides using double 32s count yarn (32/2s). The fabric width for modern technology is 56 inches, while for intermediateand handloom technologies it is 40 inches. The notation used for the table are similar to those used for the previous tables however few additional notation were used to describe various technologies. For modern technology, M_1, M_2, M_3 and M_4 signifies the four stages of production, while UK, Jap, Ind and Rum stands for UK, Japanese, Indian and Rumanian sources of machinery. In intermediate technology, 1S1, IS2, 1W1 and 1W2 signigies the stages of production, while S and SPC stands for the Service sector and spinning by pedal charka. As regards the KVIC, which only combines spinning technology, the KVS1 and KVS2 signified the first two stages of production. For handloom, T_2 signified preparatory weaving, while H_1 and H_2 stood for Pit and C.R looms(Semi-automatic) It is to be noted that M_1(OPT) and M_2 (OPT) signifies the optimum pre-spinning and spinning technologies among the modern sources of machinery and would be combined with the Pit and semi-automatic looms of the handloom technology. This is because, other

8A/ Charka and Cottage Industries Organisation, Comilla, Bangladesh

TABLE 4.2
TECHNOLOGIES SELECTED FOR EVALUATION

Technologies	Stage 1 Pre-Spinning	Stage 2 Spinning	Stage 3 Pre-Weaving	Stage 3 Weaving
A. ORGANISED SECTOR				
Modern Technology				
Technology 1	M1UK	M2UK	M3UK	M4UK
Technology 2	M1JAP	M2JAP	M3JAP	M4JAP
Technology 3	M1IND	M2IND	M3IND	M4IND
Technology 4	M1RUM	M2RUM	M3RUM	M4RUM
B. ORGANISED AND TRADITIONAL SECTORS				
Modern and Handloom Technologies				
Technlogy 5	M1(OPT)	M2(OPT)	T2	H1
Technology 6	M1(OPT)	M2(OPT)	T2	H2
C. ORGANISED, DECENTRALISED AND TRADITIONAL SECTORS				
Modern, Intermediate and Handloom Technologies				
Technology 7	M1(OPT)	M2(OPT)	SC	H1/H2
D. DECENTRALISED SECTOR				
Intermediate Technoloies				
Technology 8	IS1	IS2	IW1	IW2PL
Technology 9	IS1	IS2	IW1	IW2PDL
E. DECENTRALISED AND TRADITIONAL SECTORS				
Intermediate and Handloom Technologies				
Technology 11	IS1	SPC	T2	H1/H2
KVIC and Handloom Technologies				
Technology 12	KVS1	KVS2	T2	H1/H2
Technology 10	IS1	IS2	T2	H1/H2

modern spinning technologies would be less effecient when combined with the handloom technology. The objective here is to identify the optimum effecient technologies from among the different sectors of textile production. The technology combination of modern spinning, service centre and handloom would only consider either Pit or C.R loom , depending on the type of loom which proves more effecient.when combined with the modern spinning technology. The same type of loom would be combined with the RFC, ATDA and the KVIC spinning technologies.

SOURCES OF DATA

Technical and economic data for modern, intermediate,KVIC and handloom technologies have been collected according to the data requirement stated in Chapter-3. As the study is country specific, it warranted a comprehensive knowledge of the characteristics of the textile industry in Bangladesh for both modern and the traditional sectors. Visits were made to several textile mills using alternative sources of machinery of different vintages. For handloom, direct interviews were conducted keeping in view the locational variation factors. As for intermediate technology, the sources of information were entirely from India as this technology is not in practice in Bangladesh. Visits to different decentralised spinning and weaving units were undertaken. However for powerloom, infromation were collected from Bangladesh. KVIC technology is not generally used , except in a single organisation in Bangladesh and information on this technology were gathered from this institution and from different Khadi institutions situtated in various parts of India. Data sources and their characteristics for all the technologies have been discussed below :-

Modern Technology

Machinery prices for modern technology from UK,Japan,Rumania&India have been collected from the Manufacturers' sales agent in Bangladesh. 9/ It was found that , a complete range of machinery from Opening and Cleaning to Weaving are not available from a single source of manufacturer. To overcome such constraint, an attempt was made to replace sub-process machinery from the same country source, but from different manufacturer. Where such machinery was not available, different sources of machinery or synthetic machinery with relative price differential have been used to calculate the estimated prices for the same country origin. This has been discussed in the following chapter.

Estimate of building and infra-structural costs have been calcu-

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9/ The local agents are located in Dhaka,Bangladesh, and they are for UK : James Finley and Co. Ltd.; USA: Textile Consultant; Japan : Marubeni and Nichiman Co. Ltd.; India : Levetus and Sidko Ltd.; Rumania and France : BTMC.

lated from the Planning and Development Directorate of the Bangladesh Textile Mills Corporation. The estimates for building cost varies with the location of the plant. This variation could be due to the difference in transportation cost, availability of building materials and building workers locally and accessibility to power connections and to the location itself. Such variations have been accomodated in the calculated estimates for buildding cost.

The data on financial and technical characteristics have been collected for alternative sources of machinery. A total of eighteen (18) textile mills have been selected out of which 5 are integrated. Samples have been based on locational variability i.e mills at different locations in Bangladesh, as well as on different unit sizes and technological vintages These data cover a period of 5 years from financial year 1976-77 to 1980-81. Mills commissioned after 1972 i.e since Bangladesh came into being have been given the priority in selecting samples. A details of the sample selected have been shown in appendix 4.2, a summary of which has been given in table 4.3.

As emphasis has been put on alternative sources of machinery, therefore information were collected on machinery from UK, Japan, Rumania and India. It was found that information covering a five years' period were available for British and Japanese machinery only, while for Indian and Rumanian machinery they were for three years and one year respectively. The other difficulty was faced while seeking information on preparatory weaving machinery and looms. It has been mentioned earlier that since 1972 only spinning units were installed in the textile mills. And prior to that i.e during 1950-70 all the looms installed were from Japan (See Chapter-2) , therefore , information on technical characteristics for machinery from UK, Rumania and India are not available. Assumptions on the productivity and other characteristics of these machinery would have to be made as and when necessary.

Private Sector Weaving

This sector provides information mainly on power looms. Powerlooms are locally manufactured and the prices and installation cost

TABLE - 4.2

Details of the Selected Samples

No. of Samples	Code	Manufacturer and Model	Number of Spindles, Looms
Central Zone			
Spinning Unit			
1.	A	Platt,UK(1968)	12,480
2.	B	Howa,Japan(1962);Platt,UK(1968)	24,880
3.	Gl	Platt-Sacolowell,UK(1970)	12,480
4.	J	Howa,Japan(1975)	25,056
5.	L1 &L2	Laxmi-Reiter,Texmaco & Textool(1976)	25,056
Integrated Unit			
6.	F	SPG.: Toyoda,Japan(1958,1964 & 1968)	29,800
		WVG.: Toyoda,Japan(1962 and 1964)	192
7	P	SPG.: Toyoda,Japan(1962)	12,720
		WVG.: Sakamato,Japan(1964)	176
8	R	SPG.: Howa,Japan(1962)	12,400
		WVG.: Sakamato,Japan(1964)	176
Southern Zone			
Spinning Unit			
9	G	Toyoda,Japan(1964 & 1969); OMM,Japan(1966)	27,024
10	H1 & H2	Howa,Japan(1970); Toyoda,Japan(1975)	20,736
11	I	Toyoda,Japan(1975)	12,768
Integrated Unit			
12.	C1	SPG.: Ishikawa,Japan(1955);Platt,UK(1970)	26,608
	C2	WVG.: Toyoda(1963 and 1964)	207
13.	Q	SPG.: Howa,Japan(1962)	12,400
		WVG.: Sakamato,Japan(1964)	176
North Zone			
Spinning Unit			
14.	E	Platt,UK(1971)	12,480
15.	K	Howa,Japan(1978)	25,056
16.	M	Laxmi-Reiter,India(1976)	25,056
17.	N	Texmaco,India(1976)	25,056
18	O	Uniria,Rumania(1976)	25,056

of this machinery have been collected from the local manufacturer. Information on machine productivity, manning and technical and economic characteristics have been obtained from 5 local cotton textile manufacturers producing mainly special type of products from cotton and synthetic yarn viz. bed-sheets, towel, shirting, etc.

Intermediate Technology

There is no single manufacturer or supplier for this technology. The machinery prices have been collected from several sources. The price of pedal spinning has been obtained from the ATDA, while for that of preparatory spinning and spinning frame with 48 spindles , they were collected from South India. The currently used ATDA preparatory machinery for the Service Centre are re-built machinery, and as the prices of the ATDA proposed small-scale machinery were not available, therefore the prices of re-built machinery collected from South India, have been used. The prices of preparatory weaving machinery viz. Hank to Cone-Winding, Pirn Winding and Sectional Warping have been collected from South India and Bombay as well. All these prices have been used to combine a complete production process of intermediate technology.

The building structure for intermediate technology have been discussed in data requirement. Their construction differs from the modern sector and estimates of the building cost have been made on the basis of the information supplied by the Civil Engineering Department , Dhaka Engineering University and the Planning and Development Directorate of the BTMC.

Technical and economic data have been collected in accordance with the data requirement, from the three decentralised units in

India. All information on th ATDA, Service Centre technology were collected during the recent visit to the ATDA Head Office at Lucknow and the Pilot project at Kushmi Kalan (Uttar Pradesh), India. 10/ Information on the productivity of pedal charka and beam have established from direct visit and observation of these machinery in villages around Kushmi Kalan.

Information on decentralised spinning and weaving (Rural Fabric Centre) were collected from the KVIC unit in Coimbatore, South India, while on a visit there. A central Opening and Cleaning unit which supplies laps to the RFC unit,have also been visited to collect partinent technical and economic data.

KVIC Technology

There are a number of sources available in India, who produces equipment for the New Model Charka unit. Information on the machinery prices have been obtained from the Head Office of the KVIC in Bombay and from a manufacturer in Ahmedabad. And information on productivity and mainatenance and on the technical characteristics have been collected from several sources. The technical information on the production system organised by the distribution of Ambar Roving and Spinning at cottage level (See technology - 11) and with the aid of input and other services supplied by the Khadi Institution have been collected from Ahmedabad where a short questionnaire was administered among a sample of 10 Rovers and Spinners. Information on the Institution which organises cottage spinners have also been acquired from personal visit and cover such aspects as the network, marketing, production development and tanning. Information on the New Model Charka units were collected from the two units, one situated in Coimbatore, South India and the other in West Bengal. The technical and economic data have been compiled with aid of a questionnaire designed for these units.

10/ Had several meetings with Mr. M.K. Garg in May and September, 1982 regarding the development of proposed Cottage Spinning technology. Some of the work-shop which are manufacturing these machinery were also visited. Although, Mr. Garg was hopeful that all the machinery will be ready by 1983.but it transpired that it would take a while before they can actually be brought into operation.Information until September,1984 shows very little progress has been made so far.

Handloom Weaving

Technical and economic data on this sector is very scarce. Although there are some information available on the production and cost characteristics from the Handloom Board, but they suffer from a large variations . The Handloom Census -1978 have shown some production figures/per loom based on two-months' yarn consumption according to which the perloom production/day comes to about 13.46 yds; whereas the consumption figure given by the Bangladesh Bureau of Statistics suggest it should be 7.98 yds(See Chapter-3). Moreover these production estimates are based on different type of product.Information on preparatory weaving, for example , equipment price, production, manning/are operating costs are not/readily available. Therefore to enable a proper evaluation of this sector, detailed information on technical and financial characteri -tics are required. As the handloom is concentrated in different pockets of the country, and their numbers, looms and product types vary according to the historical development ,therefore any infroma tion on the sector should accomodate such variations.

A questionnaire had been designed and personally administered to collect information from the cottage handloom weavers. A sample size of 215 cottage weavers were selected from four handloom concentrated areas of Bangladesh. The sample size of the respective areas are selected as shown in the table 4.3.

TABLE 4.3

Handloom Samples

Division	Division's Capacity as a % of B.desh	Samples taken from Districts	No. of Samples (Units)	As a % of thetotal Samples
PIT LOOM (represent 62 % of the total Handloom)				
Rajshahi & Khulna	40.78	Pabna,Khustia and Dinajpur	94	57
Dhaka	34.15	Narsingdhi and Tangail	71	43
C.R LOOM (represent 23 % of the total Handlooms)				
Rajshahi & Khulna	64.34	Pabna,Khustia and Dinajpur	34	69
Dhaka	33.70	Narsingdhi and Tangail	15	31

The number of samples have been selected on the basis of the shares of the Pit and the C.R looms of the total looms. Samples have also been chosen based on their district and division level concentrations in Bangladesh. Care has been taken while selecting the samples to include units which have five or less looms, however,a few units with more than five looms is also included in the samples. It is to be noted that , handloom units with five or less looms represent about 72 per cent of the total handloom capacity (See Chapter- 2) in Bangladesh.

Technical and Economic Parameter for Evaluation

It is necessary to establish the parameter under which the alternatives already established are to be evaluated. These parameters will include both technical and economic factors, which will have to be defined and clearly stated before the evaluation. The purpose of this study is essentially to compare the suitability of modern, intermediate and traditional technologies and examine their possible combinations for achieving economic effeciency and employment generation under Bangladesh conditions. The obvious difference in characteristics of product and equipment, as well as productivity, differential wage rate/and other technical and economic factors of all the sectors require careful and close examinations before any useful appraisal of the alternatives is forwarded. In the ensuing discussions attention will be given on such important issues as economic and technical factors and their bearing on technology choice.

Sub-Process Wastage Level for Alternative Technologies

The sub-process wastage level for modern, intermediate and traditional technologies is very important. One of the technical features of modern technology is that it is designed to have lower wastage level. Intermediate and traditional technologies, on the other hand, inherits a higher level of wastage because of more material handling. In order to achieve a comaparable level of outpu by all the alternatives, the intermediate and traditional technologies need to process more materials than the modern technology.11 This would certainly increase the processing time and cost for these technologies, in other words would increase their operating cost. The sub-process wastage level for modern and handloom technologies have been calculated from a survey of 18 textile mills an from interviewing 215 cottage weavers in Bangladesh. While for intermediate and KVIC technologies, the infromation was collected from India. Table 4.4 shows the sub-process wastage level for modern, intermediate and handloom technologies.

No difference in sub-process wastage level is found between modern and intermediate power spinning. The wastage level of

11/ As for example, intermediate technology woul require 3 drawing operations as compared to 2 for modern technology. For traditional technology, warping and sizing operations are repeated twice before the final warp beam is prepared.

TABLE 4.4

Wastage Level of Different Technologies

(in percentage)

SPINNING

Technologies	Opening & Cleaning	Carding	Drawing	Roving	Spinning	Cone Winding	Reeling	Bundle Press
Modern	5.0	3.0	2.0	2.0	2.0	1.0	0.5	0.5
Intermediate	5.0	3.0	2.0	2.0	2.0	1.0	o.5	0.5
KVIC(Khadi -Ambar)	5.0	3.0	2.0	3.0	3.0	-	0.5	0.5
Intermediate(Pedal)	5.0	3.0	2.0	3.0	3.0	2.0	-	-

WEAVING

	Cone Winding	Pirn Winding	Warping	Sizing	Drawing & Reaching in	Weaving	
Modern	1.0	0.5	1.0	1.0	-	Warp	1.0
						Weft	0.5
Intermediate	1.0	1.0	1.0	1.0	-	Warp	1.0
						Weft	1.0
Traditional	2.0	1.5	2.0	1.0	-	Warp	1.0
						Weft	1.0
Service Centre	1.0	-	1.0	1.0	-	Warp	1.5
						Weft	1.0

Source: BTMC and Handloom,Bangladesh; ATDA(Kusmi Kalan) and Rural Fabric Centre(Coimbatore),India(Own survey data) .

pedal spinning (ATDA) and KVIC technology are identical but higher than modern and intermediate(RFC) power spinning for sub-processes: Roving and Spinning .They are 3 per cent at each stage as compared to 2 per cent for modern and RFC power spinning. For weaving, the wastage level between modern and intermediate(RFC) technologies (pedal and power looms) varies at the sub-process level pirn-winding and weaving by only 0.5 per cent. However, this variation is very significant for handloom weaving at almost all the stages. The wastage level for ' Service Centre ' is identical with that of RFC preparatory weaving technology, as because the technology in use are the same. Although,intermediate technology would have been expected to have a higher wastage than the modern , but observations did not discover this. It could be due to the difference in the grade(quality) of cotton used and the product quality. However, the wastage levels are considered as they are found. It is assumed that with regular maintenance and waste control for a single product type these wastage level would be a good estimate across technologie

Product Choice and Type

The selection of product is an essential aspect of technology choice. It is possible to produce a specified product with the help of alternative technologies, but the ultimate product may differ in quality and characteristics. This problem may limit an unqualified comparison between alternative technologies . However, the textile industry poses less interdependence between the sub-processes than many other industries like the chemical industry, and there are opportunities within the sub-processeslevels to modify the output by quality control in order to achieve the required product type. The most important aspect of the quality of the yarn is its regularity and strength , while for fabric it is its compactness and tearness strength. 12/ Any difference in the quality of the product or in the above measures could either be due to the quality of the raw-cotton used or the process itself. It is generally

12/ Yarn strength is measured by Count Strength Pound(CSP) values, which is calculated as Count X Breaking strength in lbs.

TABLE 4.5

PRODUCT SPECIFICATION

YARN

32s Cotton Yarn

FABRIC

Warp : 32s Cotton Yarn
Weft : 32s Cotton Yarn

Structure

Type : Grey
Warp : 54 ends/inch
Weft : 54 picks/inch

Modern Sector Weaving

$$\frac{32s \times 32s}{54 \times 54} \times 56$$

Unfinished cloth width = 56 inch
Selvedge = 0.25 inch on both ends with 32/2s Cotton yarn
Total nos.of ends : 56 x 54 + 27 = 3051
Total nos.of pick/yd : 36 x 54 = 1944

Intermediate and Traditional Sector Weaving

$$\frac{32s \times 32s}{54 \times 54} \times 40$$

Unfinished cloth width = 40inch
Selvedge = 0.25inch on both ends with 32/2s Cotton yarn
Total nos.of ends : 40 x 54 + 27 = 2187
Total nos.of picks : 40 x 54 = 2160

the case that the quality of product suffers when textile process moves from modern to intermediate and to traditional technologies. However, it is technically possible to maintain an uniform strength of yarn by using progressively higher quality cotton towards the traditional end of the technology spectrum. But, it would reflect on the cost per unit of output, and on prima facie,will increase across the technologies. It can be concluded therefore,that there will be some difference in product characteristics due to the use of alternative methods of production. However, in textile process, it is possible to overcome this problem partially if the product is of medium to lower quality i.e the fineness of the yarn used is below 40s English count. The number of sub-process increases beyond this count,when the quality control becomes relatively more important. 13/ The table 4.5 shows the product type selected for yarn and grey cloth for this study.

The yarn type chosen is of 32s English count . The reason for selecting this particular count is two fold. Firstly, this particular count of cotton is the largest share of yarn at prsent produced by the local mills (38.6 per cent) and also because it is widely used by the handloom sector. Secondly, this product can be produced with the help of all the technologies, without effecting much of its quality, such as strength and uniformity. ATDA and KVIC experimental results show that the yarn CSP values, a measure of strength, is comparable to mill yarn . 14/

The fabric type would be in grey form and is assumed to be using the same intermediate output i.e.yarn of 32s count.The construction of the fabric is important, because it determines the quality, unit

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13/ When yarn count is increased beyond 40s cotton count, the additional sub-processes viz. Lap former and Comber would be required to increase the fineness and strength of yarn. However, where fineness is not too important,higher count Carded yarn is also manufactured.

14/ CSP values of ATDA,RFC and KVIC spun yarn lies between 1,350 - 1,600, when modern mills spun yarn have a CSP values between 1,400 - 1,800.

cost and also the market it is producing for. Although, a wide variety of construction of the fabric is technically feasible, but for the purpose of comparison between alternative technologies the fabric construction consisting of 54 picks and 54 ends will be considered. The reason for selecting this fabric type being that it is a medium quality fabric and widely in use in Bangladesh. The modern composite mills and the handloom produce about 90 and 72 per cent of their product in medium quality respectively.

The Scale of Output (Q)

The scale of output has been estimated based on the assumption that maximum technical economy of scale would be realised from the modern machinery . In the modern production process,the important machinery i,e the spinning frame and the loom individually possess small capacities. It is technically feasible to combine one spinning frame with 20 looms without having any adverse effects on the diseconomies of scale , but the problem arises when other sub-process machinery viz. Opening and Cleaning, Warping and Sizing are included in a single production process. Pickett and Robson have stated that because of the high capacity of Opening and Cleaning machinery, the optimum technical economy of scale would be realised at an annual output level of 26 million sq. yds. 15/ Even at that output level the Warping and Sizing machinery had utilised only 50 per cent of their capacities . The output level, however, varies with the type of product and the construction of woven fabric. In general,the finer the quality of yarn keeping the construction same, the higher would be the level of output. As mentioned the scale of output(Q) would be decided on the basis of the production capacity of the modern machinery. This has an obvious advantage, unlike modern machinery,the machinery and equipment available for intermediate and traditional technologies are relatively divisible. Therefore, the output level fixed through modern technology would be attained by combining a number of machinery or units available in intermediate and the dispersed sector.

15/ The Choice of Technology in the Production of Cotton Cloth, by Pickett, J. and R.Robson , Scottish Academic Press,1981. pp. 32-33.

At this stage , an UK output level would be used as the basis for standard output for comparison(See Chapter-5 for details). As alternative sources of machinery were explored for modern sector production , it was found that spinning frame from several sources had almost identical features as shown in table 4.6 ;:-

TABLE 4.6

Spinning Details of Alternative Sources of Machinery

Sources	Max. Rated Speed(RPM)	Ring Diameter(inch)	Lift (inch)	Recommended Speed(RPM)	Prodn./ Spdle/Shift
UK	16,000	1.75	9	13,200	4.55 oz
JAPAN	16,000	1.75	9	13,000	4.48 oz
INDIA	16,000	1.75	9	13,000	4.48 oz
RUMANIA	16,000	1.75	9	12,900	4.45 oz

The production per spindle per shift or/annum could be calculated if the product type (the yarn count), the twist inserted per inch (t.p.i) and the spindle speed are known. 16/ If the number of spindles are known, then the total yarn output could be estimated This intermediate yarn output could be directly used for preparatory weaving and weaving processes to obtain grey fabric as an output. In order to calculate the final output two basic information are required; one is the number of spindles used and the other is sub-process wastage level. The number of spindles could be estimated either considering the initial production capacity ofthe Opening and the Cleaning sub-process(in lbs)and subsequently by making allowances for sub-process wastage level of the following operations viz.Carding,Drawing and Roving and Spinning to arrive at the amount of material required to be processes at the spinning sub-process level If the spindle r.p.m, the type of product and t.p.i are known, then

16/ The formula used for calculating spindle production is :

$$\text{Production/spindle/shift} = \frac{\text{Spindle speed(RPM)} \times 8 \times 60 \times 16}{\text{TPI} \times \text{Count} \times 36 \times 840} \text{ (oz}$$

the number of spindles can be calculated (Pickett and Robson, 1981). However, another method which is in practice in Bangladesh, assumes that an Opening and Cleaning unit of a machinery with one scutcher is balanced with 12,500 spindles (approx)and similarl a unit with two scutchers is balanced with about 25,000 spindles. In fact there is very little difference between these two methods, except for the product type and the production capacity in each sub-process level takes account of maintenance breakdown and other underutilization factors. 17/

The number of spindles have been selected according to the scale of unit in Bangladesh, i.e about 25,000 spindles. 18/ In the case of machinery from UK the number of spindles to be considered, is 24,960. However, the exact number of spindles may not be attained because of the limit in the number of spindles per frame which vary for different machinery sources. This spindle capacity(latter which produces 32s cotton count is expected to have 5.63 million lbs. of yarn as output annually. If this intermediate yarn output is being directly processes then the output achieved would be 37.1 million sq. yds. annually taking into consideration the allowances for wastage at different sub-process level. This output level could be the basis of comparison for alternative technologies. When assessing the annual production in terms of running yards then the output would depend on the width of the looms, as shown in the table 4.7 given below :-

TABLE 4.7

Output Level of Alternative Technologies

Technologies	Loom Type	Loom Width (inch)	Annual Prodn. in Running yds
Modern	Automatic	56	23,869,020
Intermediate	Pedal & Power	40	33,416,630
Traditional	Handloom	40	33,416,630

17/ Both the types of unit exist in Bangladesh.(See table 4.2). In calculating the number of machinery for each sub-processes level, about 15-20 per cent above the required total sub-process production capacity is taken by the BTMC for

Most of the modern automatic looms are 56 inches in width, although it is possible to have forty inches width of cloth in the same loom , Power looms and handlooms are found to be weaving identical width of cloth of 40".

(For Production Build-Up See Page 40)

Working Days and Shift-Production

The number of working days observed in mills in Bangladesh vary between 300 to 345 days. In the present study it has been taken as 300 days in a year. Shift working is essential to reduce the impact of rising investment cost. The organised sector has the advantage of organising production on 3-shift basis, while the decentralised and the/dispersed sectors may not be able to run on 3-shift basis. The intermediate technology runs on 3-shift (ATDA) and 1-shift basis (RFC). The KVIC factory type units operate on 1-shift basis. The pedal spinning and the handloom do not strictly maintain any shift and may work from 4 to 12 hours a day with seasonal variation in operation. Taking into consideration these variations in shift and working time, the following shift -basis have been assumed for the Organised, Decentralised and Traditional sectors as shown in table 4.8

TABLE 4.8

No. of Shifts for Alternative Technologies

I	Modern Spinning and Composite Unit	- 3 shift
II	Intermediate Spinning and Powerloom Weaving	- 3 shift
III	Intermediate Pre-spinning and Spinning	- 3 shift
IV	Service Centre (Preparatory Weaving)	- 3 shift
V	KVIC Ambar Charka	- 1 shift
VI	Pedal Spinning	- Average dail production
VII	Handloom Weaving	- Average dail production

Although, ATDA pre-spinning (Roving) and RFC power spinning runs either on 3 shift or 1 shift basis, but in the present case both the technologies have been regarded to operate on 3-shift basis. It can be argued that there is no technical limitation, rather it could be

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balancing. The excess production is taken for maintenance, break-down and other factors.

18/ Since Bangladesh came into being in 1971, all most all the textile mills commissioned had capacity of 25,000 spindles, with the exception of one which had capacity of 12,480 spindl

Production Build-Up

It has been assumed that the construction and the installation work would be complete within the 33rd month of the project. At the last month of the 3rd year the trial production will commence (See project-life , table 4.9). It has been estimated that during the initial 3 month period, the operational effeciency would be between 45 to 50 per cent. This will achieve 12 per cent of the full production capacity. In the 4th year, the operational effeciency attained would be between 70 to 75 percent , and the production achieved would be 84 per cent of the full production capacity. In the 5th year, the production level achieved would be 100 per cent of the production capacity i.e 5.63 million lbs of yarn or 37.13 million sq. yds. of grey cloth. It has been assumed that the intermediate and traditional technologies would have production capacity build-up which corresponds with this.

an organisational matter to operate on 3-shift basis. Handloom and pedal spinning production would be based on average daily production which would also take account of seasonal variations.

Project Life

The total working life of the project is assumed to be 20 years. However, the total project life would differ from its working life, for instance, in the organised sector the total life is taken to be 23 years. It has been assumed that the development of land, the construction of building and installation of machinery would take about 33 months. The project would go on trial production on the 34th month. For intermediate technology (ATDA and RFC) and the KVIC, it has been pre-supposed that the total time for construction and installation of machinery would take 21 and 9 months respectively, while the trial production would start on the 22nd and the 10th month . In the case of handloom, it would be assumed that these looms are newly installed in the cottage weavers' home. The construction time required and the project/life across the technologies have been shown in the table 4.9 below :-

TABLE 4.9

Construction Period & Project Life Of Alternative Technologies

Technologies	Project Life Span (year) 1	2	3	4	5 to 23
Modern	C	C	C/TP(12%)	PL(84%)	PL(100%)
Intermediate					
ATDA & RFC	-	C	C/TP(12%)	PL(84%)	PL(100%)
KVIC	-	-	C/TP(12%)	PL(84%)	PL(100%)
Traditional	-	-	P(12%)	PL(84%)	PL(100%)

Notations: C : Construction
TP: Trail Production
PL: Production Level

The assumptions above have been made on the basis of the infortion on, the organised sector collected from the BTMC, the intermediate and KVIC technologies from the Indian survey and the traditional technologies from the handloom survey.

The Life of Machinery

Any meaningful comparison among the technologies largely depends on the assumption that the life of machinery across the technologies would be identical. Such a supposition would be open to criticism and hence some explanation and adjustments are essential. As far as modern machinery is concerned , a 20 years working life do not provoke any argument. In fact, it has been observed in Bangladesh , that the technology vintage of 1936 is still in use, even though the manufacturers of such machinery do no exist any more.(See Chapter 2). As regards intermediate technology the assumption of equal life span of 20 years invites some doubt. Moreover, some of the spinning and weaving preparatory machinery have been re-built from 1930-1950 vintage. Evidence which is in favour of assuming an identical life of machinery comes from a sample visited in Coimbatore, India, which was established in earl 1971. During the visit , it already had a life-span of 11 years without any major maintenance work done on it. The KVIC Ambar Charka machinery were observed to have similar life pattern. However, some machinery cost adjustment for intermediate and KVIC technologies would help to strengthen the equal life assumption. From the technical point of view, spinning and weaving machinery could have a life of 40 years, ignoring technological obsolescence, it is the drafting system which would need modernisation. 19/ Pack (1976) has argued that differential maintenance cost which favours second-hand machinery because of the local availability of

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19/ Discussion with the machine manufacturer of ATDA,RFC and KVIC machinery, and with the Shirley Institute,Manchester suggest that the assumption of identical life is valid,but a modernisation of 'Drafting System' is required for these technologies during the project life time.

skills and workshop, lower wage rate of maintenance workers justifies the assumption of identical life span. This argument can very well be applicable here. In fact, the obsolescence of textile machinery is dominated by technological development i.e, higher speed, larger can size and higher spindles diameter &/lift rather than any mechanical failure. The reason for obsolescence is also dominated by economic suitability rather than any technical incapability. In the case of traditional technology, i.e, handloom, this argument is not plausible and an equal machinery life assumption would not valid. Although, it is possible to replace some of the important parts of the loom , but even then the main loom frame may not have a life span of 20 years. In the present study, two types of looms have been taken as alternatives, they are the Pit and the C.R looms. The handloom survey establishes that former can have a life of 6 to 8 years, but needs many replacements , while the latter could have a life of 12 to 15 years with complete overhauling. From what has so far been discussed, it would be reasonable to assume the machinery life of different technologies as follows :-

I	Modern Technology	-	20 years working life
II	Intermediate Technology (ATDA & RFC and KVIC)	-	20 years machine life but a major modernisation required during the project life.
III	Traditional Technology (Handloom)		
	a/ Pit loom	-	Replacement of the machinery four times during the project life.
	b/ C.R loom	-	Replacement of the machinery twice during the project life.

Investment costs are required to be adjusted according to the machinery life as stated above. For handloom, the machinery life has been assumed to be lower than the observed machine life. The reason for doing so could be explained as some of the handlooms are not presently utilized to their full extent. If the utilization increases, then the life-span of the looms would be shortened.

Location of the Project

The location of the project is an important factor influencing investment and operating costs. The textile industry in Bangladesh is almost totally dependent on imported machinery, spares and raw-materials, therefore, the location of the plant from the sea-port has a bearing on the investment and as well as a long term effect on the operating cost. When comparing alternative technologies using different input and labour and producing for different markets, the locational factor becomes important. To overcome this problem, adjustments on transportation cost and some assumptions have to made. One of the assumptions could be, that both the organised and the decentralised sectors using imported machinery are located in the proximity of the sea-port. The traditional may also be assumed to be in the same region. As a result, the variation in transportation and distribution costs can be overcome. The other locations could be anywhere in Bangladesh. Existing locational pattern shows that Dhaka and Chittagong the two most important cities,dominate the concentration of modern textile mills, because of market and structural facilities (See Chapter 3). The Government policy of decentralisation since 1973 has helped to increase the number of mills in other regions of the country and is likely to bring about further increase. However, as the concentration of handloom is in few pockets of country mainly dominated by Dhaka district which has a highly developed market with adequate demand,it may likely to initiate further growth of the textile industry in and around Dhaka. As regards intermediate and KVIC technologies, it may be pointed out that these technologies are not presently in operation in Bangladesh, except for one hand-spinning and weaving unit located just in the outskirts of Dhaka district.

Considering the present structure of the textile industry, it has been assumed that the organised mills would be located near the Dhaka city, while the intermediate and the KVIC ytechnologies would be located in the Dhaka district in close proximity to the handloom concentrated areas. It may be argued that Dhaka being located in the centre of the country could represent a distan distance covering 2/3 rds of the country. This can also be substantiated by the fact that the details on transportation cost are available from this location. However, as the plants using intermediate and KVIC technologies would be located near the handloom concentrated areas, their access and infra-structural facilities would not be as developed as for those located near the Dhaka city, therefore would require some adjustments in the transportation cost.

Power Consumption

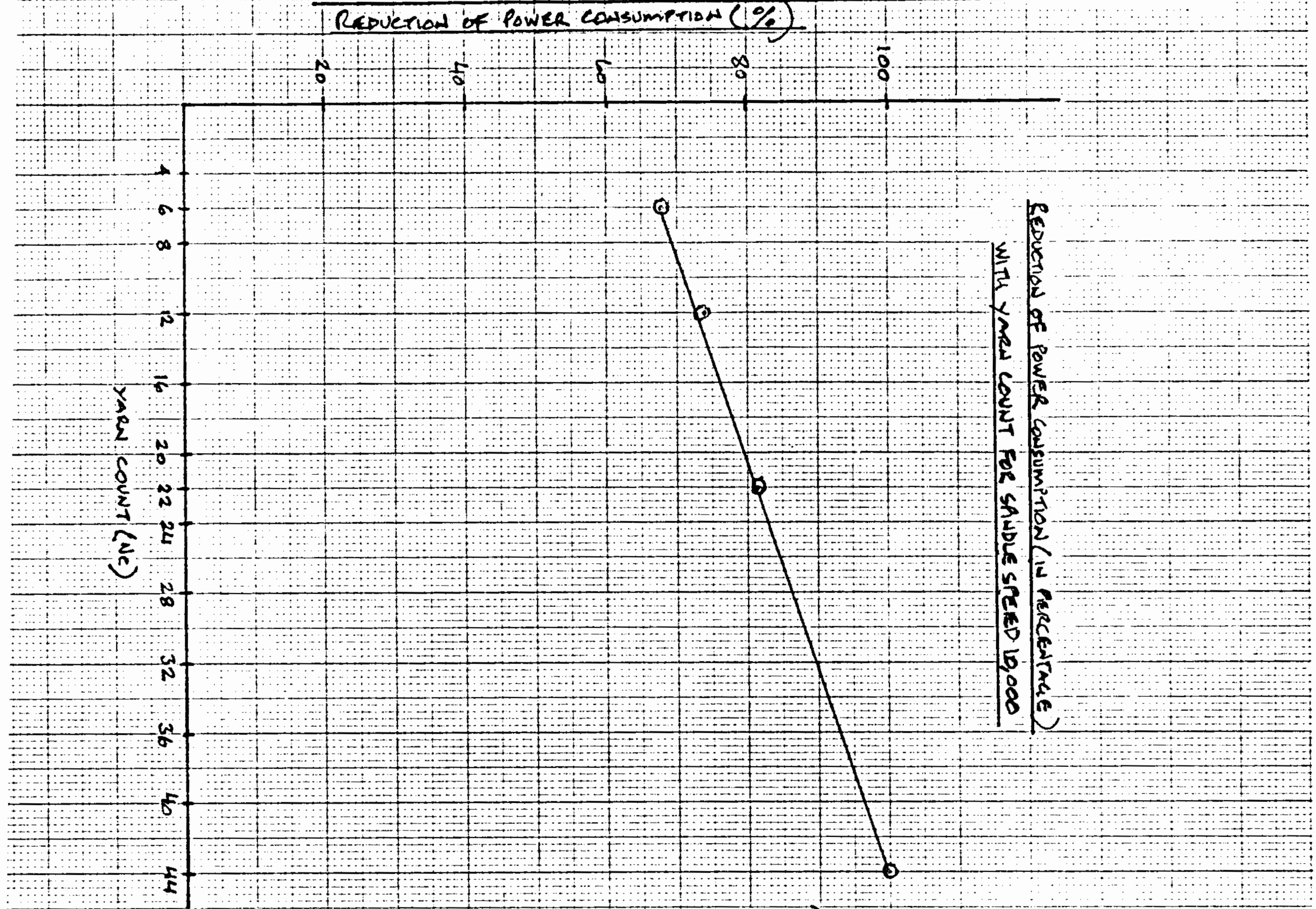
The power cost is an important component of the operating cost. The manufacturer's technical literature contain information only on the installed power which may not be the same as the observed power of the machinery. The noteworthy sub-process where the maximum energy is being consumed is the spinning process and its power consumption may vary with the spindle speed. This variation has been taken into account while determining the power consumption cost. The power may be consumed by essentially two distinct sources : (a) Preparatory spinning and weaving (Warping and Sizing) and Weaving, and (b) Spinning, Cone-Winding and Pirn Winding). The consumption for the sub-processes in (a) usually occurs at a constant manner, whereas for (b) it increases with the build-up of the package. Therefore, the observed power consumption should take note of motor effeciency, variation in yarn count and spindle speed.

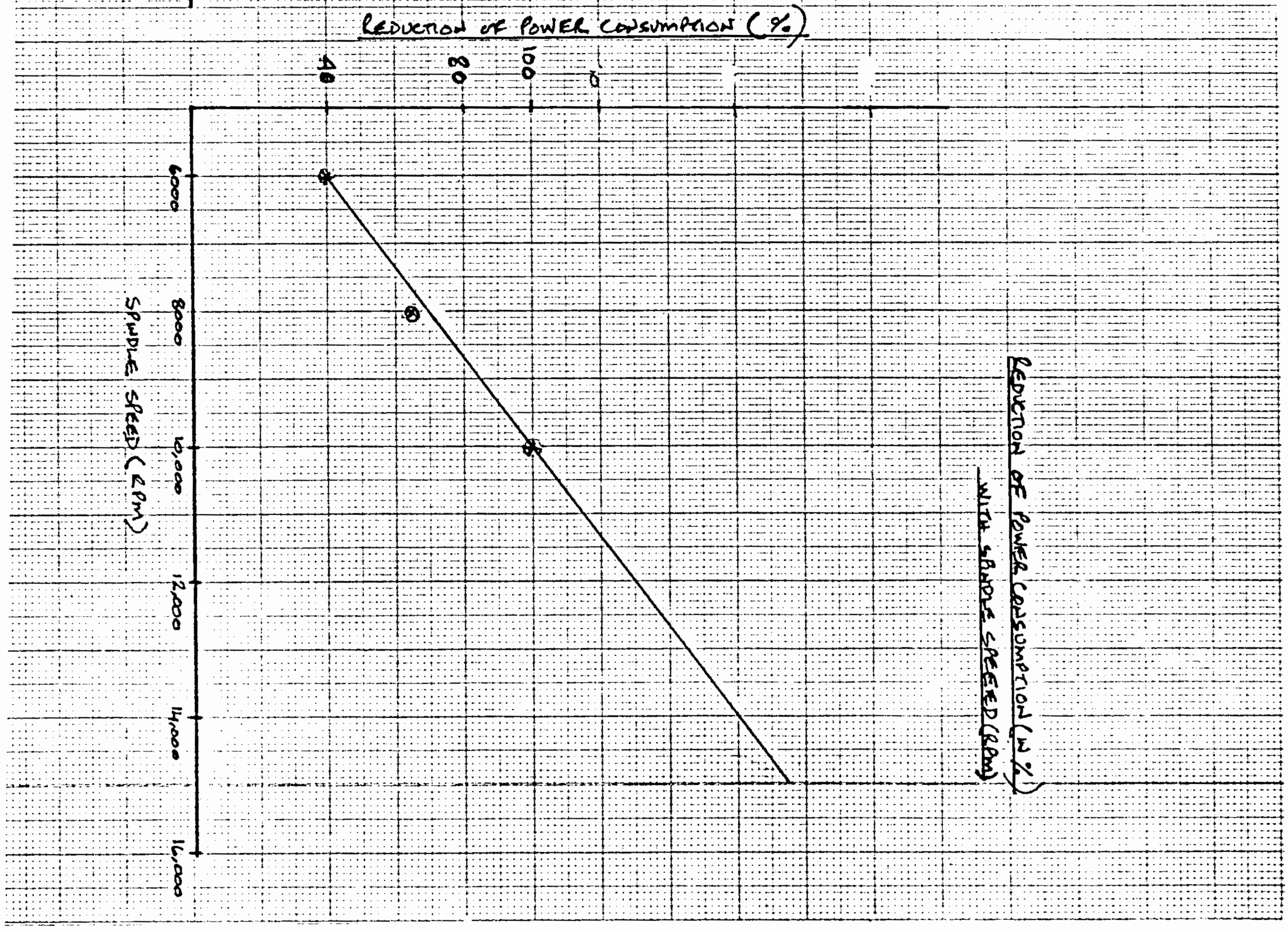
It would be reasonable to assume that under Bangladesh condition, the motor effeciency would be about 90 per cent, which is somewhat higher than the observed motor effeciency. Power consumption for sub-processes in (a) would be 80 per cent of the installed motor capacity, while for Ring Spinning, it has to be adjusted for product type (32s count) and spindle speed. Catling and Barr have shown the variation in the power consumption with relation to yarn count and the spindle speed. 20/ The result

20/ The Principles and Theory of Ring Spinning (Manual of Cotton Spinning Vol. 5), by Catling, H.R. and De Barr .A.E., The Textile Institute, Manchester. pp. 161-194.

Figure 4.6

Variation in Power Consumption with Spindle Speed & Count





presented by them could be used to construct two graphs as shown in figure 4.6

The graph (i) shows the relationship between the change in yarn count from 6 to 44s and the power consumption in terms of percentage with spindle speed at 1,000 r.p.m. It appears that for 32s count the observed power would have to be adjusted by a factor of 0.84.

The graph (ii) indicates an possible relationship between power consumption (in terms of percentage) and spindle speed for 32s cotton count. This graph has been drawn from the result presented by Catling and Barr and represents an estimate of the reduction of the power consumption with the spindle speed. It has been assumed that these estimates would suffice for the present purpose of the study. These two graphs will be used as guidelines to help determine the power consumption, as and when necessary.

PRODUCTIVITY ASSUMPTIONS FOR ALTERNATIVE TECHNOLOGY SOURCES

Productivity can simply be defined as the ratio between the output and the resource consumed. It is important to consider productivity as a measure of effeciency. A standard or the expected level of productivity have been considered, which can be achieved by the alternative sources technologies viz. UK, Japan, Rumania and India to attain the comparable scale of output(Q). The expected level of production or machine effeciency has been based on the manufacturer's recommendation under Bangladesh condition. It is to be noted that the selection of the number of machinery has been influenced by this effeciency level, and therefore the number of machinery for different technologies would vary when attempting to achieve a comparable scale of output(Q).

However, in actual situation the manufacturer's recommended effeciency or productivity level often fails in attaining the comparable output. The findings reveal that two mills of identical size using machinery of the same vintage and ahaving the same maintenance standard can differ widely in the productivity per unit output. Pickett and Robson's cross-sectional data suggest that this variation is significant in the developing countries. 21/ This variation in productivity can be attributed to

I Technical and
II Organisational factors

The technical factor may be attributed to the machine speed and the operating effeciency of the spindles and looms. The spindle speed, for example, depends primarily on yarn count twist factor and the fibre strength. Spindle effeciency on the other hand, is determined by calculating the ratio of the theoretically possible capacity of one spindle operating at a maximum speed an actual capacity i.e the ratio between the rated output (CR) and the actual output. For spindle or loom capacity as opposed to its rated capacity, the manufacturer recommends an operable capacity for specific

21/ 'A Note on Operating Condition and Technology in African Textile Production', by Pickett,J. and R. Robson, World Development, Vol. 5, No. 9/10, UK,1977, pp. 879-882.

country condition which could be defined as recommended or expected capacity (C_m). However, the actual capacity (C_a), which is attainable under the country condition is lower than the manufacturer's recommanded capacity. The relationship between the rated, expected and actual capacities could be defined as follows :-

$$C_r \geqslant C_m \geqslant C_a$$

In practice, C_a is often lower than C_m and the difference in output per unit time can be defined as production deffeciency (D_f). Under a country condition where the best management practices are available and with no x-ineffeciencies, it is possible to attain $C_m = C_a$. Pickett and Robson have shown that it is possible for the African countries to achieve the UK effeciency, moreover, sometimes Hongkong textile productions exceed UK productive effeciency. Production deffeciencies embody two modifying factors: (i) avoidable and (ii) unavoidable stoppages. In theory, the avoidable stoppages can be completely eliminated as they could be due to yarn breakage, 22/ developing country condition, etc. Although, unavoidable stoppage such as power failure can not be eliminated, nevertheless they can be improved upon by collective effort. The power failure is found to be the major cause for low productivity in Bangladesh. In 1979-80 and 1980-81, about 9 and 6 per cent of the total production time had been lost due to power failure.

Isolated from the machine speed, the operating effeciency would depend on the level of the training which the workers had received and which the management can monitor and improve upon. The atmospheric and the hygenic conditions within the mills also effect the machine and labour productivity. The organisational aspects of achieving the manufacturer's recommended capacity or effeciency is very important, and as has been mentioned earlier that Pickett and Robson (1977) have found a significant variation in productivity because of different management practices.

In the present study, alternative sources of machinery from UK, Japan, Rumania and India have been considered. The task at

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22/ Yarn breakage depends on humidity, spinning room cleanliness, quality of roving and count produced(finer counts requires a careful pre-spinning preparation.

the present would be to ascertain the productivity of the existing spinning or composite units which use these sources of machinery and relate their productivity to estimate the actual productivity that could be achieved from the new machinery. It is important to mention here that the machinery already in use are of older vintages. They are likely to have lower speed than the weaving and spinning machinery to be considered for the evaluation of alternative technologies which are of 1981 vintage and have relatively higher speed. Therefore, adjustment would have to be made for the improved machinery speed before applying the productivity level obtained from the existing mills.

Productivity Measurement

It is essential to assess the productivity level of the 18 sample mills which use UK, Japanese, Rumanian and Indian machinery. The actual productivity level obtained for the sample mills would have to be adjusted for the improved machine speed and the power failures which reduce (lower) the actual productivity. In textiles, several methods for the measurement of productivity are widely in use. One such method necessitates the comparison of a mill with a standard mill having optimum organisation and labour consumption. The second method known as the , 'Van den Abeele System' in which the organisational index is worked out by comparing the actual man-hours required to produce one hundred kilogram of yarn (actual HOK) with the man-hour expected under the specific condition prevailing in the mill (prevailing HOK). The expected HOK is worked out in each mill according to the equipment and condition present in the particular country. 23/ The essential difference between these two methods is that the first method established a standard mill with the aid of 'productivity centre' and then compared other mills in relation to it. Whereas the Van den Abeele method examines productivity achievement within the same mill by constructing Productivity Index (PI), from the

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23/ Technological and Economic Aspect of Establishing Textile Industry in Developing Countries, UNIDO, Vienna, 1967 pp. 111-149.

ratio between the actual and the productivity which can be achi achieved with the existing equipment working at maximum effeciency and with labour factor at the optimum level. A third productivity measurement used by ATIRA, India also calculates the PI index for inter mill comparison.24/The Productivity Index is defined as follows :-

$$PI = \frac{\text{Machine Productivity Index (MPI)}}{\text{Labour Employment Ratio (LER)}} \times 100$$

$$\text{Where MPI} = \frac{\text{Mill Production per Machine Shift}}{\text{Standard Mill Production per Machine Shift}}$$

$$\text{And LER} = \frac{\text{Mill Operative per Shift}}{\text{Standard Mill Operative per Shift}}$$

The ATIRA method of calculating Productivity Index gives a relationship between the machine productivity and the labour employment ratio. This PI could be usefully measured for the purpose of this study , but would require some assumptions. If it is assumed that the mill operatives required per shift is determined by the BTMC and correspond exactly with the standard mill operatives, which is also set-up by the BTMC then LER becomes = 1. 25/ This could be same across all technology sources, and therefore the measurement of PI becomes simpler :-

$$PI = MPI$$

Productivity index would then be a function of machine Productivity Index,and since the manning level is more or less identical across the technologies, labour productivity would depend on the performance of specific technology sources. MPI is a ratio between the actual and the standard machine production. If it is assumed that, the standard machine production is , in fact, the manufacturer's recommended or the expected production under the

24/ Inter-firm Comparison of Productivity and costs, published by Ahmedabad Textile Industry's Research Associatio,India, 1978 pp. 1-5

25/ The BTMC has standard manning level schedule,which it applies to all mills irrespective of their technologies,however,they may very according to the number of machinery.

country condition then PI could be expressed as :-

$$PI = \frac{\text{Actual Capacity of Machine/Shift}}{\text{Expected or Standard Machine Capacity/Shift}} \quad (i)$$

It can also defined as

Recommended Effeciency

$$(Reff) = \frac{\text{Expected or Standard M/C Capacity/Shift}}{\text{Rated Machine Prodn./M/C/Shift}} \quad \frac{(CM)}{(CR)} (ii)$$

Actual Effeciecny

$$(Aeff) = \frac{\text{Actual Prodn./Shift/M/C}}{\text{Rated Machine Prodn./M/C/Shift}} \quad \frac{(CA)}{(CR)} \ldots (iii)$$

From these a fourth relationship can be arrived at, which is

$$(Aeff) = \frac{CA}{CM} \cdot Reff. \quad \ldots\ldots (iv)$$

The utility of the relationship derived from (i), (ii) and (iii) is that if the actual, expected and the rated machine capacities are known for both the old and the new vintages, then by calculating PI for the older vintages the actual capacity of the new machinery can be estimated. This can be done by simply combining the PI with the expected machine capacity which is the product of rated capacity and recommended or expected effeciency. The equation 1 to 1V can be used to analyse the data collected on the 18 textile mills to establish their producitivity indices (PI). These PI can then be employed to calculate the actual productivity level for the 1981 spinning and weaving machinery from the alternative technology sources, for the purpose of the present study. It is to be noted that under the standard mill condition the values of PI, Reff and Aeff $\leqq$ 1 or 100. Ideally, PI and the effeciencies can be calculated for all the sub-processes and then combined to give an overall index. However, the efforts here had been to concentrate on two main sub processes viz. the spinning and the weaving. It has been assumed that the productivity level of these sections would represent the overall spinning (stage I and II) and weaving (stage III and IV) productivity levels. This can be justified as the prevailing sub processes of the spinning and the weaving are continuous and also they represent the final processes of intermediate (yarn) and final (grey cloth) product.

Productivity Estimates for 1981 Machinery

Spinning Technology

The producitvity indices for the 18 textile mills with UK, Japanese , Indian and Rumanian spinning machinery have been calculated. The table 4.10 provides a detailed information on the machinery vintages, spindle diameter , lift and speed ,recommended or expected effeciency, expected and actual production, etc. It could be seen from the table that the number of samples from UK, Japan , India and Rumania are 5, 7, 4 and 1 respectively. The selection of samples were designed to accomodate the mills with newer vintages of machinery . It has been found that Indian and Rumanian spinning machinery were first installed in Bangladesh only after 1975, and at the time of the survey there were only 4 Indian and 1 Rumanian mills are in operation , although a number of them were under installation.

The table shows that UK spinning machinery from vintages between 1968-71 had recommended speed between 11,000 to 11,500 r.p.m with an expected per spindle production between 3.41 to 3.56 oz per shift.. However, the actual spindle attained is between 8,200 to 9,130 r.pm with spindle production between 2.83 to 3.3 oz per shift. It indicates that the calculated producitvity index varied between 81.5 to 92.7. The average index for the five (5) samples is 87.02. Similarly, the PI of the Japanese, Indian and Rumanian spinning machinery have been calculated and they are 90.3, 85.55 and 87.36 respectively. It further appears from the table that the Japanese spinning machinery has achieved the highest productivity level among all the technology sources, followed by Rumania , UK and India. The productivity levels of Rumania and UK are almost the same and are relatively higher than the Indian spinning technology. It is to be noted that the productivity level for the Rumanian technolgy is represented by a single mill , while for other sources it is more widely represented.

It is possible to use the PI index which has taken into consideration the recommended or expected effeciency and production capacity and the actual production level , to estimate the productivity

TABLE 4.10

PRODUCTIVITY INDEX FOR THE SURVEYED MILLS(SPINNING)

		Spindle Details			Production(Oz.)					
Sample Code	Vintage	Recommended Speed(rpm)	Lift (inch)	Ring Dia. (inch	At Rec. Speed	Rec.Eff. (90 %)	Actual Prodn.	RPM at Actual	PI	Actual Eff.(Aeff)
Source : UK										
A	1968	11,000	8	1.75	3.79	3.41	3.1	8,984	90.9	81.81
B	1968	11,000	8	1.75	3.79	3.41	2.83	8,200	83.0	74.70
C	1970	11,500	8	1.75	3.96	3.56	2.90	9,130	81.5	73.35
D	1970	11,500	8	1.75	3.96	3.56	3.3	9,274	92.7	83.43
E	1971	11,500	8	1.75	3.96	3.56	3.1	8,984	87.0	78.3
									Av.87.02	
Source : JAPAN										
F	1968	11,000	8	1.75	3.79	3.41	3.15	9,130	92.4	83.16
G	1968	11,000	8	1.75	3.79	3.41	3.30	9,565	96.8	87.12
H1	1970	11,500	8	1.75	3.96	3.56	2.98	8,636	83.7	75.33
H2	1975	12,000	8	1.75	4.14	3.72	3.25	9,420	87.4	78.66
I	1975	12,000	8	1.75	4.14	3.72	3.40	9,855	91.4	82.26
J	1975	12,000	8	1.75	4.14	3.72	3.35	9,710	90.1	81.09
K	1975	12,000	8	1.75	4.14	3.72	3.36	9,740	90.3	81.27
									Av.90.3	
Source : INDIA										
L1	1976	12,000	9	1.75	4.14	3.72	3.28	9,505	88.2	79.38
L2	1976	12,000	9	1.75	4.14	3.72	2.95	8,550	79.3	71.37
M	1976	12,000	9	1.75	4.14	3.72	3.33	9,650	88.7	79.83
N	1976	12,000	9	1.75	4.14	3.72	3.20	9,275	86.0	77.40
									Av.85.55	
Source : RUMANIA										
O	1976	12,000	9	1.75	4.14	3.72	3.25	9,420	87.36	78.62

level which could be expected from the new machinery. The productivity index could be multiplied with the expected level of production and effeciency of new spinning machinery of all sources to estimate their actual achievable production. Accordingly, the estimated actual level of production per spindle have been calculated for UK, Japanese , Indian and Rumanian technologies and shown in table .

It can be seen from the table that the rated spindle speed of all the technology sources varies between 15,5000 to 16,000 r.p.m while the recommended speed varies between 12,900 to 13,200 r.p.m. At the recommended spindle speed its production varies between 4.451 to 4.555 oz per spindle per shift . The expected production which takes into account the recommended or expected effeciency, varies between 4.010 to 4.095 oz/shift. UK has the highest spindle production of 4.095 oz/shift followed by Japan and India both having identical spindle capacity of 4.037 oz/shift and finally followed by Rumania which has spindle production of 4.010 oz/shift. It is to be noted that the expected levels of production are the recommendations of the manufacturer which have been based on the country's operating conditions. The determination of the comparative scale of output (Q) for the alternatives has been based on the modern technologies, and would therefore depend on their expected level of production (See scale of output(Q)). However, it appears from the table 4.11 that the actual level of spindle capacity is much lower than the expected level. The estimated actual level of spindle productivity for UK, Japanese, Indian and Rumanian technolgogies are 3.563, 3.645. 3.454 and 3.503 oz per shift. It shows that the actual spindle speed which could be attained for all the technologies would lie between 10,010 to 10,565 r.p.m, while the actual effeciencies would vary between 77 to 81.27 per cent. It could be seen from the table that although the UK machinery have higher rated and expected capacity but its actual spindle production falls below the Japanese level. Accordingly, the expected per spindle productivity of UK and Japanese are 4.095 and 4.037 oz/shift respectivley, while the estimated actuals reveal them to be 3.563 and 3.645 oz/shift respectively. The actual effeciencies attained by different technology sources

TABLE 4.11

ESTIMATED SPINDLE PRODUCTIVITY FOR 1981 MACHINERY

Source of Machinery	Spindle Details: Rated Speed(RPM)	Lift (inch)	Ring Dia. (inch)	Expected or Recommended: RPM	Prodn. Cr(oz)	Eff(%) (Reff.)	Prodn. Cm	PI 1/	Actual Estimated: Production (oz)	Speed (RPM)	(Aeff).
UK	16,000	8	1.75	13,200	4.555	90	4.095	87.02	3.563	10,325	78.32
JAPAN	16,000	8	1.75	13,000	4.486	90	4.037	90.30	3.645	10,565	81.27
INDIA	16,000	9	1.75	13,000	4.486	90	4.037	85.55	3.454	10,454	77.00
RUMANIA	15,500	9	1.75	12,900	4.451	90	4.010	87.36	3.503	10,150	78.62

viz. UK, Japan, India and Rumania are 78.32 , 81.27, 77.0 and 78.62 respectively.

Weaving Technology

Weaving in Bangladesh, likewise spinning is dominated by Japanese technology. Unlike in spinning , no new weaving preparatory machinery and looms were installed in the country since 1950. External procurement of all weaving machinery in the form of composite units took place in the 1960s from Japan(See table 2.8). As the textile policy pursued since the 1960s discouraged the installation of modern automatic looms in the cotton textile sector , information available on the producitivity level of weaving machinery and looms are only from the 1960s vintages of Japanese origin. As this study attempts to evaluate the suitablitlity of both spinning andweaving machinery from all the four country sources therefore, the absence of weaving machinery from sources other than Japanese limits the determination of the actual productivity level. To overcome this constraint a bold attempt in assuming that productivity levels of the other sources viz. UK, India and Rumania are identical to the Japanese has been made. Such assumptions can be made on the grounds that the productivity level for weaving is less variable across the technologies as because the loom technology for the alternative sources are similar. The table shows the recommended pick per minute (ppm), effeciencies, expected and actual production capacities of 1962, 1963 and 1964 technology vintages.

The table 4.12 shows that the pick per minute for different vintages varies between 140 to 145, while the expected production of cloth per shift varies between 34.58 to 35.81 yds. The variation is small as all the technologies are from vintages of three consecutive years. However, the difference between the actual production is relatively greater and is from 26.96 to 28.46 yds per loom per shift. The calculated production index (PI) varies between 83.65 to 92.42 yds. and the average for the five (5) composite mills is 87.38 yds. As for spinning, the produciton index could used to estimate actual achieved producitivty of 1981 weaving technologies, provided information is available on the rated, recommended or expected production capacity and effeciencies of all

TABLE 4.12

PRODUCTIVITY INDEX FOR THE SURVEYED MILLS(WEAVING)

Spindle Code	Vintage	Expected or Recommended: Picks/min. (PPM)	Prodn. (yds)	Eff. Reff(%)	Prodn. (yds)	Actual Prodn(yds)	PI	Actual Eff. Aeff(%)
Source : Japan								
F	1962	140	34.58	90	31.12	28.76	92.42	83.18
C2	1964	145	35.81	90	32.23	27.25	84.55	76.10
P	1964	145	35.81	90	32.23	28.36	88.00	79.20
Q	1964	145	35.81	90	32.23	26.96	83.65	75.28
R	1964	145	35.81	90	32.23	28.46	88.30	79.47
						Av.	87.38	78.65

TABLE 4.13

ESTIMATED LOOM PRODUCTIVITY FOR 1981 MACHINERY

Source	Loom Details: Rated PPM	Width (inch)	Type	Expected or Recommended: PPM	Prodn. Cr(yds)	Eff. Reff(%)	Prodn. Cm(yds)	PI	Estimated Actual: Production (yds)	(PPM)	Aeff.
UK	190	60	Battery	170	41.99	90	37.79	87.38	33.02	134	78.65
JAPAN	160	60	Battery	150	37.05	90	33.36	87.38	29.15	118	78.65
INDIA	170	60	Battery	180	39.52	90	35.57	87.38	31.08	126	78.65
RUMANIA	170	60	Battery	160	39.52	90	35.57	87.38	31.08	126	78.65

machinery sources..

Based on the assumption that the productivity level for weaving is identical across the technologies, the calculated PI has been multiplied with the expected production capacities ascertain the actual productivity level of weaving technologies for all the sources of machinery. The table 4.15 shows the expected and the estimated actual producitivity levels for alternative sources of weaving technologies. The recommended or the expected capacities of UK, Japanese, Indian and Rumanian technologies are 41.99, 37.05 , 39.52 and 39.52 yds. respectively. The comparative scale of output(Q) for the alternative technologies have been calculated based on the expected level of production. However, the estimated actual producitivity level for the technology sources UK, Japan, India and Rumania are 37.39, 33.36. 35.57 and 35.57 yds. per shift per loom respectively.

Adjustment of the Number of Working Days at Actual Estimated Productivity

The scale of output (Q) selected for this study has been based on 300 days and on the expected level of machine producitivty recommended by the manufacturer at the country condition. This parameter has been extended here to take into account the actual productivity level already estimated for spinning and weaving. The rationale behind is that the expected producitivity level would be achieved in a situation where there is no x-effeciencies in management practice and the operation effeciencies are at a optimum level. Such a situation is already said to be in existence in the textile factories of Hongkong and Africa. Pickett and Robson (1981) have emphasised on the relationship between effecient management and the choice of technology. They concluded that the gains from effeciency is greater than the losses incurred by uncritical choice. 26/ Therefore, it is essential that both the actual and expected productivity levels of the technologies are evaluated.

26/ The Choice of Technology in the Production of Cotton Cloth, op. cit., p.164.

As the actual producitivity is below the expected productivity level than the scale of output can not be maintained in 300 working days. Therefore, the number of working days need to be extended . However, if the actual productivity level is too low then the comparative scale of output may not be attained by a spinning or a composite unit in the same year. In such an intance, additional machinery would have to be installed and consequently the investment cost would increase to meet the comparative scale of output. While if the actual production is able to achieve the comparable scale of output within a year (i.e 365 days) but beyond 300 days , then it can be argued that the scale of output can be attained without increasing the investment cost but with extending the number of working days. The extension of the working days would be reflected in additonal operating costs i.e increase in labour, power, maintenance and overhead costs. For increased working days no additional workers would be employed rather the presently employed workers would work on an overtime basis. It would be relevant to mention here that presently there are some mills in Bangladesh which operates on 345 working days.

Adjustment of working days would be required for modern, intermediate and traditional technologies. As the productivity level for pedal, power, pit and C.R looms, ATDA pedal and KVIC hand spinning have been based on actual production adjustment in the number of the working days is not required for these technologies. But adjustment is needed for modern spinning and weaving technologies for which the actual production of 1981 machinery from UK, Japan, India and Rumania have been estimated. For intermediate technology, the expected productivity level of RFC spinning have been taken from observations made in India. It has been assumed that the actual productivity level of Bangladesh would be lower than the Indian. The Indian productivity level has been modified in accordance with the spindle production Iin Bangladesh of machinery from 1927 and 1936 vintages. 27/ The technical features of these machinery are

27/ There are quite a few mills, which use mostly of 1927-1936 (se Chapter-2), The spindle production of these mills are quite low,and they are found to be comparable with theRFC power spinning.

comparable with the RFC spinning, therefore their actual production could be considered as achievable by RFC spinning under Bangladesh condition. The number of working days for RFC Composite Unit have only been adjusted for spinning. This is because the/for Power looms productivity level was based on the productivity level observed in Bangladesh private textile sector, while for the latter the Indian productivity level is used as it was found not to be significantly different from the semi-suto looms. The table 4.14 shows the adjustment in the number of working days in accordance with the estimated actual production level of modern spining and composite units as well as intermediate RFC power spinning of alternative technology sources viz. UK, Japan, India and Rumania.

The table 4.14 shows that in order to attain the scale of output (Q) at the expected capacity, the spinning supplying yarn to the Service Centre and the handloom weavers would require to process more materials. This is because of the sub-process wastages of the Service Centre and the Handloom weaving. In order to produce an identical level of grey cloth at the expected productivity, the composite unit spinning requires 300 working days while, for supplying yarn to the Service Centre and the handloom weavers it would require 308 and 310 days respectively. At the estimated actual productivity level the number of working days is escalated for composite unit spinning from 300 days to 340, 332, 351 and 344 for UK, Japanese, Indian and Rumanian technologies respectively. Similarly, the working days increased for the Service Centre and the Handloom weaving from 308 and 310 days to 349, 341, 359 and 352 , and 351, 343, 362 and 355 respectively for UK, Japanese, Indian and Rumanian technologies. Intermediate technology at the expected capacity requires to process a higher quantity of material than the RFC composite unit . Intermediate spinning unit supplying yarn to the handloom weavers entails an increase in working days from 300 days required by the RFC composite unit to 309. At the estimated actual capacity, the number of days required by RFC composite spinning unit increases from 300 to 340 days, while for supplying yarn to the handloom weavers the same unit needs an increase from 309 to 350 days. For modern weaving at the expected level of productivity, the number of looms

TABLE 4.14

ADJUSTMENT OF NUMBER OF WORKING DAYS

SPINNING(a)

Technologies	Yarn Reqrmnt. (lbs)	Exp. Product'y: Daily Prodnlb	Exp. Product'y: No of days	At Estimated Actual Productivity: Spindle Productivity UK	JAPAN	INDIA	RUMANIA	Daily Reqd. Prodn. UK	JAPAN	INDIA	RUMANIA	Adjusted No.of Days UK	JAPAN	INDIA	RUMANA
MODERN TECH.															
SPG(Composite)	5,558,950	18,530	300	3.56	3.64	3.45	3.50	16345	16730	15854	16174	340	332	351	344
1/SPG+SC+Handl'm	5,698,480	18,530	308	3.56	3.64	3.45	3.50	16345	16730	15854	16174	349	341	359	352
SPG+Handloom	5,741,480	18,530	310	3.56	3.64	3.45	3.50	16345	16730	15854	16174	351	343	362	355
INTERMEDIATE															
RFC SPG+Pedal or Power loom	5,586,080	18,580	300	-	-	2.41	-	-	-	16,432	-	-	-	340	-
RFC SPG+Handlm	5,741,480	18,580	309	-	-	2.41	-	-	-	16,432	-	-	-	350	-

WEAVING(b)

Sources of Technology	Cloth Prodn. (yds)	Loom Prodn (yds)	No.of Looms	Daily Prodn. (yds)	No.of Days	Estimated Actual Prodn(yds)	Daily Production (yds)	Adjusted No. of Days
UK	23,869,020	37.79	725	79,585	300	33.02	69,540	343
JAPAN	23,869,020	33.36	825	79,570	300	29.15	69,520	343
INDIA	23,869,020	35.57	775	79,605	300	31.08	69,555	343
RUMANIA	23,869,020	35.57	775	79,605	300	31.08	69,555	343

Note: 1/ SC = Service Centre

have been selected in such a manner as to ensure the attainment of the comparable scale of output (Q) by all the alternative technology sources viz. UK, Japan, India and Rumania in 300 working days. It has been assumed that at estimated actual producitivty level all the alternative technology sources would have productivity level identical with the Japanese. Hence, the required number of working days would increase in the same proportion for all the technologies which is an increase from 300 to 343 days for all weaving technologies.

Wage Rate and Administrative Salaries

In Bangladesh where most of the manufacturing activities take place in the public sector, the wage and salary structure is uniform throughout the country and is known as the National Pay Scale (NPS). The basic wage and the salary scale is the same, however, the kind of allowance may vary in different cities, for example the house rent allowances are higher in cities than in small district towns. The wage and the salary structure has been designed to accomodate the skill composition of both labour and administrative personnel and accordingly they are remunerated. Therefore, if the investment for the organised sector is undertaken by the Government then this wage structure would be employed. Fortunately, there are specific wage and salary structure available for the textile sector which takes account of the skill composition and these structure can be directly used. But as the intermediate and the KVIC technologies are not in operation in Bangladesh, and therefore considerable difficulty arises in determining the wage level for these sectors. The Indian wage rate for these sectors could serve as guide-line and help to alleviate the constraint; but the Indian wage level is found to be quite high for these sectors and even excess than the organised sector wage level. Further problem arises from as to which source shall initiate investment in these sectors. The wage level may vary according to whether the investment is being undertaken by the Government or by private entrepreneur. The other wage areas to be considered are handloom and pedal spinning . For these areas, the wage level observed as mentioned in the Handloom Survey and a handspinning unit in Bangladesh could be used. It is essential for the study , to define first of all, the sources of investment clearly and then assume the wage structure that would be appropriate for the different sector technologies

Modern Technology

It would be assumed that the modern sector investment would be executed under public sector ownership i.e the ownership presentl existent . It would therefore be quite relevant to use the wage and salary structure at present in use in the textile industry. The textile sector wages are broadly the same as the NPS, and can, however be broadly categorised into seven wage scales(grades).

The table 4.15below shows the wage grades for the BTMC :-

TABLE 4.15

BTMC Wage Scale(Grades)

(All in Taka)

Grades	Monthly Pay Scale	Av.Monthly Pay(TK)	Total Allowances	Total Pay/month
I	270-8-325	310	159	469
II	285-10-410	332	167	499
III	300-12-440	388	187	575
IV	310-12-470	408	194	602
V	335-15-520	450	208	658
VI	355-20-555	485	221	706
VII	400-28-555	585	256	841

The wage scale shows the monthly pay starting from the point, July, 1977. In the scale (i.e the 2nd column) the figures in the middle signify annual pay increments. The average wages have been calculated for the year 1981, and allowances have been taken as 35 per cent of the basic salary for house rent and gratuity allowances and Tk. 50 as medical benefit. These allowances are uniform across the all the wage rates. For convenience , the above scales have been identified with the skill composition of the textile industry categorised by the BTMC Planning and Development Department for investment appraisal.These are as follows in-the table 4.16 given below :-

TABLE 4.16

Wage Scale Based on Skill Composition

(All in Taka)

Skill Composition	Type	Grade	Total Pay (Monthly)	Annual Pay
Supervisory	S	VII	841	10,092
Skilled	A	VI	706	8,472
Semi-Skilled	B	IV and V	630 1/	7,560
Un-Skilled	C_1	III	575	6,900
	C_2	I and II	484 1/	5,808

1/ Average of Grades IV and V; and I and II as appropriate.

The employment of the modern sector can be divided into the above skill composition. Once , such skill differentiation is established, it would be easy to calculate the wage component of the operating cost.

It is now essential to establish the salaries of the adminstrative and managerial staff. Once again, the salary structure for the public sector enterprises are identical across all the technologies under the National Pay and Salaries Scales.Usually, there are as many as 20 scales, but only 9 main scales have been identified which can be appropriately used by the textile sector. These basic pay scales are identical across all the textile industries in the country. However, the main allowances viz. the house rent may vary according to the location of the mills , whether they are in urban or rural areas. In cities where accomodationfor administrative and managerial staff are not provided there is provision for a fixed house rent. In places where accomodations are provided the house rent rebate is deducted from the basic salary at the rate of 5 to 7 per cent. The nine categories of administrative and management staff salaries are in the table 4.17 which follows :-

TABLE 4.17

Annual Salary of Administrative Personnel

(All in Taka)

Grade	Scale of Pay	Avge. Monthly Pay	Net All-owances	Total Monthly Pay	Total Annual Salary
I	2300-100-2750	2,675	20	2,695	32,340
II	1850- 75-2375	2,265	25	2,290	27,480
III	1400- 75-2225	1,965	25	1,990	23,880
IV	750- 50-1470	1,210	35	1,245	14,940
V	470- 35-1135	875	60	935	11,220
VI	400- 25- 825	665	85 1/	750	9,000
VII	325- 15- 610	500	280	780	9,360
VIII	300- 12- 540	445	260	705	8,460
IX	225- 6- 315	285	230	515	6,180

1/ Average monthly pay includes house rent allowance.

The pay scales shown above like that for wages start similarly from the month of July, 1977. The average wages have been taken for the year, 1981. Salary scales from I to VI consider that housing accomodations are being provided within the mill compound. Therefore deductions for house rents from the monthly pays forscales I to IV and V and VI have been made at the rate of 7.5 and 5.0 per cent respectively. While for scales VII, VIII and IX, an allowance of 30 per cent is added to the basic pay for house rent. The net allowance have been calculated by adding up all the allowances such as the gratuity at the rate of 6 per cent on the basic pay, medical allowance of Tk.50, and then dedeucting the house rent rebate from the total allowances. Once, the required number and types of administrative and management personnel for modern spinning and composite units have been decided, the total wages and salaries could then be calculated from the table above.

Intermediate Technology

It has been discussed that the wage structure depends on whether the production is being organised by private entrepreneur or the public sector. As intermediate spinning and weaving are not widely in use in Bangladesh, it would be assumed that such production structure if undertaken would be done so as in India , under public sector ownership. Such an assumption alleviates the problem of wage determination for this technology to a great extent. The National Pay Scale used for all public sector industries could/ be applied for the intermediate technology, and can aid in the establishment of the skill composition of the production activity. It would then appear that the skill requirement of the intermediate technology is relatively in the lower spectrum of the skill composition than the modern sector,. For instance in the modern spinning sub-process , a single spinning tenter looks after 432-480 spindles, whereas in intermediate spinning under factory shed (RFC Power spinning) a spinner only supervises 48 spindles, although he also helps with the doffing of full spindles. Therefore, it would be appropriate to extend unskilled workers of the organised sector by decomposing C_2 (i.e grade I and II) to C_{2A} and C_3(i.e grade II and I respectively) for intermediate technologies. Accordingly, the skill requirement would have to be adjusted for all the sub-processes of intermediate technology.

It would be convenient to use the NPS or the BTMC wage scales for the Service Centre(Stage -III), ATDA pre-spinning (Stage -I),KVIC pre-spinning (stage I upto Speed Frame), RFC spinning (stagesI and II) and pre-weaving(stage III) and RFC composite units with power looms (stage I to IV) .All these sub-processes use power driven machinery and it would be assumed here that all their operatives would be employed on a permanent basis. Furthermore, shift working is possible and have been considered for all these operations except for KVIC pre-spinning. However, the problem arises with sub-processes of the pedal charka, Ambar roving, spinning charka and the pedal loom where all the operations involve direct human power and are usually run on one shift basis. Their operatives also work on a daily basis and are paid on the amount of production they can deliver at the end of the day. 28/ Therefore , the daily or the weekly wages vary for these operatives and depend on their skills.

The wage rate for Pedal and Ambar Rover and Spinnners have been estimated from the only production centre in operation in Bangladesh. The wage rate has been related to the productivity of the machinery, as wages are paid on the basis of daily production. It has been found that the average wage paid for 32s cotton count is Tk.10 per lb. of yarn. Accordingly a spinner operating an Ambar charka could earn as much as Tk. 8.14 per day, while a Pedal charka spinner could earn Tk.19.35 at the same time. The Ambar rover on the other hand, receives 'roving' at Tk3.0 per lb. and earns a daily wage of Tk.8.66 based on the average machine productivity. However, the Ambar rover and spinner also get some food ration at a very subsidized rate and due to this

28/ In ATDA(Kusmi Kalan) spinning technology, it has been observed that the operatives of the Service Centre,who supplies roving to the Pedal spinners are employed on a permanent basis,and work on 3 shift basis. Whereas,the Pedal spinners paid by the ATDA based on the production per week.However,in RFC spinning and weaving,except for Openning and Cleaning,Carding,Warping and Sizing,otheroper-atives paid on the basis of daily production. In KVIC tech-nology,except for preparatory workers viz. Purvo and Uttar Pesai(Openning & Cleeaning,and Drawing),the other operatives are also paid on the basis of daily production.

benefit it could be assumed that their wage comes to Tk.10 per day. It would be possible to estimate an annual wage on the basis of 300 working days, which would be for Ambar rover and spinnner and the Pedal spinner Tk.3,000 and Tk.5,805 respectively. It appears that a Pedal spinner could earn the same as an unskilled worker in the organised sector.

The wage structure explained above could be appropriately employed in calculating the total wage costs for the Service Centre, ATDA Pedal, RFC Power and the KVIC Spinning and RFC Composite Unints with pedal and power looms. The salaries of the administrative personnel of the decentralised sector could be used from the corresponding salary scales identified for the organised sector. However, the administrative staff of the latter would belong to the lower end of the scale as because the organisational structure of small-scale production is relatively small. The administrative staff and their pay scale, would thereofore have to be determined accordingly. The cost elements involving the wage and salaries of the operatives and of all the above mentioned technologies can be calculated after having established the skill composition of all the intermediate technology sub-processes and the admininstrative skill requirement.

TRADITIONAL TECHNOLOGIES

The wage rate for the traditional technologies have been estimated from the survey conducted on 214 cottage weavers. It emerged from the survey that the wage rate is closely related with the productivity of the operative i.e the operatives were paid on the basis of their daily output. It,therefore, became imperative to establish the average daily production before ascertaining the daily or weekly wage rate. This wage rate could be divided into main areas viz. prepratory weaving (stage III) and weaving (stage IV) . It was found that the average production for the preparatory weaving could be established with little difficulty as the yarn which is being processed can be measured and converted into 32s cotton count very easily. Although, there may be variations in the rate of the processing cost depending on the locations, however an average could be found to calculate the daily wage rate of the handloom weavers. The wage rate vary with the type of product i.e cloth construction, yarn count and on the design used on the product. It also varies with the locations, as for example weavers concentrated near the handloom trade centres are usually paid higher wages, than those near handloom centres in remote areas. It is important to convert the product type found in the survey to the product quality used in this study (i.e 32s cotton count) before estimating the wage rate. The variation in the product type is so numerous that in order to estimate construction close to the grey fabric considered for this study have been taken. It has also been observed that the form of wages payment could abe different for example sometimes the weavers are provided with meals besides the wage payment. However, the most common wage payment in practice is based on a unit product i.e for a 'sari' which is usually 5 yds. long , a fixed amount is being paid for it. It may therefore be assumed that the handloom weavers' daily wage rate could vary according to the length of the cloth which is being produced each day. The survey has estimated the weighted average daily production which also takes into account the locational variations. According to the average daily production, the daily wage rate received by the preparatory weaving operatives and weavers have been shown in the table 4.18 below :

TABLE 4.18

Wage Rate of Handloom Operatives
(All in Taka)

Sub-Processes	Prodn./ Day/Oper-ative(lbs)	Wage Cost /Bundle (10 lbs)	Daily Wage Cost	Annual Wage Cost
Preparatory Weaving				
Bobbin Winder	3.5	12	4.20	1,260
Natai & Tana (Pre-Warper)	8.25	20	16.50	4,950
Drum-man(Warper)	16.5	15	24.75	7,425
Nali(Pirn Winder)	3.44	12	4.13	1,240
Sana & Ba(Drawing in)	16.0	6.25	10.0	3,000
Weaving				
Pit Loom Weaver	8.71yds	1.5/yd.	13.06	3,920
Semi-auto loom Weaver	11.32	1.5/yd	16.98	5,094

SOURCE: Own handloom survey on 214 cottage weavers.

The annual wages of the traditional sector show that the Bobbin and the Pirn winders receive the lowest wages of Tk.1,260 and Tk.1,240 respectively. among all the operatives. It has been observed that the operatives of these two sub-processes are either the old women or children between 8 to 14 years and sometimes housewives. Although they work all through the day (atleast 12 hours) their productivity is low because of the frequent breaks they take to do other household work. The annual wages of Drum-men (Warper) of Tk.7,425 is very close to the wage rate of the semi-unskilled worker in the modern sector, while the wages of the Drawing-in operatives which is Tk.3,000 is the asame as for the Ambar Spinner. The annual wages of the Pre-warper and the semi-suto loom weaver are almost the same , they are Tk.4,950 and Tk.5,094 respectively. These wages fall about 14.8 and 12.3 per cent between the wages of the unskilled worker in the modern sector. The annual wages of the Pit loom weaver is about 77.0 and 67.5 per cent of the semi-automatice loom weaver and the modern sector unskillled worker respectively. The wage structure of the traditional sector shows that except for the Drum-man, the wages for all the operatives fall below the wage level of the organised and the decentralised sectors.